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THE

UNIVERSAL ELECTRICAL DIRECTORY

1901 Edition

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THE PASSING OF OUR STEEL TRADE.

DOUBTLESS our readers noticed in our last issue that the contract for steel rails for the Yarmouth electrical tramways had been secured by a Belgian firm, and that the Cheltenham Electric Tramway Company had ordered 800 tons of steel rails from the United States.

We merely refer to these places as the most recent instances of what has been continually going on for some years.

We have been exercised in our minds as to the reason why English firms seem to have no ghost of a chance of securing such orders, and we applied to no less than three dozen manufacturers of steel and rails to supply us with information on the following points:—

How is it that American and German contractors can undersell our own manufacturers to such an extent as is shown in the Yarmouth example?

Is it a question of quality of metal; that is to say, are we tied down to the production of steel containing a smaller percentage of phosphorus than that supplied from (and accepted in England and all the world besides, apparently without demur), the States and the Continent?

Are our methods of manufacture as economical and rapid, and is our plant as fairly up to date, as is the case abroad, and do the hours of labour and rate of wages materially affect the result?

Now what do we find? A number of English firms reply by simply telling us that they do not make girder tram rails, and there they take leave of the matter. Some have not replied at all.

Others inform us that although they were amongst the first in the country to manufacture grooved rails for tramway companies, they have not for many years undertaken the turning out of these rails, because, being employed to their full capacity on material which they consider they are better adapted to supply, they are not now specially interested in the work.

Further still, others state that English rail rollers do not supply girder tramway rails at the price of Continental makers, for the simple reason that they can find more profitable work for their mills; and, say our informants, the American and Continental makers of these rails are able to dispose of their surplus stock abroad at a very low figure, making up their profits from the bulk of their trade which is in their own countries, and in which they are enabled to sell at a high price owing to protective duties.

It is, no doubt, very pleasant to feel that one's works are full of profitable undertakings to-day, but have English engineers no thought for the morrow, will they make no provision for the future?

The same lack of prescience in the past has robbed us of what was once a monopoly, in other branches of our industries, and the business has passed into

the hands of our foreign competitors. Now the outlook for our old-time supremacy in the manufacture of steel, one of our staple articles of commerce, is the reverse of hopeful, and our reputation in this direction is distinctly on the wane, as we shall proceed to demonstrate.

There has apparently been some little misunderstanding in circles outside the trade with regard to these tramrails, and the general public seem to be under the impression that a steel rail *is* a steel rail, and that the girder rails now used so much in tramways are the same as the ordinary rails used by large railway companies for the permanent way. This, however, is not so. The girder tramrail, which is exclusively used to be laid in masonry for street tramways, is a perfectly different article. It was originally rolled some 20 years ago in England, but was not a success, as far as the rolling was concerned, but being found most suitable for tramway work, the Germans took the matter up, invented special machinery which was necessary, and put up expensive plant at several of their works in Westphalia. Their rollings proved a very great success, and for years they had the sole monopoly of this trade. It is said that until within very recent years, scarcely an English rail of this description was laid down in the whole tramway system of London or any of the provincial towns.

One firm has supplied thousands of tons of German rails for consumption in this country, and although the same firm has often laid the matter before English makers, the latter would not go to the expense of laying down the proper plant, and were satisfied to stick to ordinary permanent-way rails and let the Germans have the whole of this tramway rail business!

Further, when English makers were only obtaining £3 10s. to £3 15s. per ton for ordinary rails, the Germans were getting orders for tramrails for this country at from £5 to £6 per ton.

The Darlington Steel and Iron Company did make an effort to produce these rails. The other firms making them are the Barrow Hematite Steel Company and the Leeds Steel Works, but these, we understand, are the only firms in this country who are at present rolling the heavy sections now required for tramway purposes.

The Americans then took up the manufacture, but it is only during the last two years or thereabouts that they have succeeded in delivering rails of the description to this country.

There is no reason to doubt that the English makers could have rolled these rails just as well and as cheaply as the Continentals and Americans, had they taken the matter up a little earlier; but they were very supine in the matter, and evidently did not foresee the very large increase in this business which the introduction of electric tramways has caused. They did not think the quantities required were sufficient to warrant their laying down the necessary plant, or, at any rate, did not care to do so; consequently the foreigners have stolen a march upon them, and it will be very difficult indeed for them to recover the lost ground.

Of course, the present high prices may be accounted for, to some degree, by the increased cost of wages and raw material, which has taken place in this country during the last two years; but the main reason is the fact that there are practically only two works in this country who can make these rails, and that even they have had nothing like the experience in rolling them which the Germans have.

Here, again, the English character shows itself in the indifference to foreign competition, and the total neglect of a rapidly expanding industry which brings grist to the mills of the Fatherland and those of the West.

Would that our manufacturers could have have instilled into them the spirit which animates the pages of Prof. Perry's eloquent little work on "England's Neglect of Science."

Then would they learn how Germany has an enormous advantage just now in the fact that all thinking Germans believe that their great success in commerce has come through physical science. Every German manager and foreman has passed through the science classes of a great technical school, and Germany is getting covered with Universities of Science.

The open-hearth process has enabled German ores of iron to be used in steel manufacture, but, as the Professor argues, England had the start. Every country that has coal and iron is competing with Great Britain. The countries of greatest natural resources can afford to neglect their scientific education longer than others, but, sooner or later, knowledge and method and character must tell. Just think of it, says Prof. Perry. Here we are, a hard-headed, obstinate, cool race of men, who have had no end of chances in our tight little island, with coal and iron, and the influx of good foreigners to set us first in the new field, and we have more than half of all the wealth in the world, and all that is needed for our keeping our good things is, that we should believe them to be possibly evanescent—that there really is a chance that some better equipped nation may take them away from us, and, therefore, that we ought to prepare ourselves to fight for them.

We have many chances in our favour, and we hardly use them; the competing foreigner is very energetic, and cultivates his smallest chances. As for the United States, we learn, on the authority of *Commercial Intelligence*, of the 16th inst., that, after a somewhat lengthy period of negotiation, the great consolidation of iron and steel interests has at last been accomplished, and Mr. Morgan, who seems to be the leading spirit of the combination, hopes to put the American steel industries in a position which may make them a more formidable rival than even now to the steel industries of Europe.

Tesla's Wireless Telegraphy.

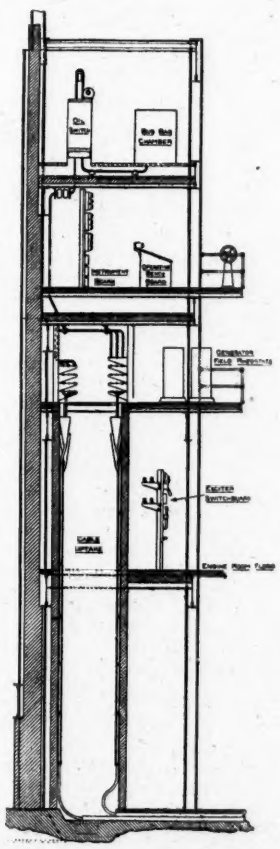
Tesla has now come down from the clouds to *terra firma*. His last great scheme was to transmit electric energy through the higher regions of the atmosphere to the uttermost parts of the earth. The practical realisation of that scheme appears to have been dropped for the present. The new scheme is to telegraph across the Atlantic, and presumably in time to greater distances, by electric waves generated in the earth. We learn from accounts of interviews with the inventor, published in the daily Press, that three distinct experimental evidences that the plan is practicable, have already been obtained by him. One of these, is, we are informed, the existence of "stationary electric waves" in the earth, a fact which demonstrates that vibratory currents can be transmitted through the earth just as through a wire, to the greatest distances. Another evidence was obtained by ascertaining the law of variation of the intensity of effects at different distances, by which an apparatus could be designed for any required distance. The third evidence was obtained by the actual measurement of the intensity of effects through varying distances of 650 to 700 miles. Leakage of messages is to be prevented by tuning the receiver to the transmitter, in connection with which tuning Tesla has devised certain contrivances which he does not describe. There is nothing theoretically impossible in Tesla's scheme of creating ripples in the great reservoir of electricity in the earth. The chief practical obstacle is the law of inverse squares, which plays havoc with the intensity of waves at great distances. Tesla may have discovered a method of generating waves of an intensity hitherto unheard of, and may thus succeed in beating the present record for wireless telegraphy. But otherwise it is doubtful if there is much novelty in his scheme. It has been suggested, we believe, by Lodge, that Marconi telegraphy operates by electric waves passing through the earth, and not by Hertzian waves passing through the atmosphere. As long as the conductors in which the waves are generated are connected to earth, it is difficult to decide whether the signals pass through the earth or the air. It is to be hoped that Tesla is not again exciting, as in his last great scheme, expectations that are never to be realised—We see no reason for an immediate fall in telegraph cable shares.

THE ELECTRICAL EQUIPMENT OF THE MANHATTAN ELEVATED RAILWAY.

By E. KILBURN SCOTT.

(Concluded from page 264.)

Switching Apparatus for Alternating Currents in Power House.—In general organisation and arrangement the alternating current switching apparatus resembles in many features that of the switchboard of the Niagara Falls Power Company, and also that used in the Metropolitan plant. At Niagara compressed air is used to operate the switches, admission of the air to the switch cylinders being controlled by levers manipulated by the operator. In the case of the Metropolitan plant, compressed air is used to operate the switches, but the admission of air to the switch cylinders is controlled by electro-magnets which in turn are electrically actuated by small switches, concentrated upon the controlling or bench board, immediately in front of the operator. On the Manhattan Railway all the switching apparatus will be controlled electrically without the intervention of compressed air, the large switches being operated by means of electric motors, working in conjunction with powerful springs. The motors, and, therefore, the switches are in turn controlled by electric circuits, which pass through the small switches immediately under the hand of the operator. The controlling switches are so arranged upon the bench board, in conjunction with certain dummy bus bars and connections, as to give at all times to the eye of the operator an accurate diagrammatic representation of the existing connections of alternators, switches, bus bars and feeders.



Section of Switch Galleries.

The indicating devices consist of bull's eyes illuminated by small incandescent lamps, which will be supplied with current over the operating wires from the oil switches and by a circuit completed through the motor of the oil switch, so that the lamps are at all times a guarantee of the integrity of the circuit. Two of these lamps will be used for each oil switch, one to indicate that it is closed, and the other to show that it is open. The lamps thus serve as a check on each other in case of the failure of the filament or any broken connection in the lamp circuit. The two bulls-eyes for each switch will be of different colours, red to indicate the switch is closed and green to indicate that it is open. Opaque strips closing the pilot diagram of circuits under the red bulls-eyes and opening the pilot diagram of circuits under the green bulls-eyes will also be used to apparently complete the diagrammatic circuit connection, the operator thus having at all times an exact representation of the actual connections of the alternating current circuit, and not having to trust to memory to determine what alternators are connected to one or the other set of bus bars, nor what bus bars are connected to each other.

The instrument board is 28 feet long and contains all indicating instruments for alternators and feeders; the instruments for each alternator being mounted in a vertical row. At the top are three ammeters combined in one case. Below these are placed a voltmeter, an indicating wattmeter, with a scale reading up to 10,000 KW., and a power factor indicator. By means of the relative readings of the last-named instrument the operator will be enabled to accurately adjust the relative field excitation of the various alternators, thus minimising the magnetising cross currents between the alternators.

The power factor indicators will also serve as an automatic signalling device between sub-stations and the power house, for the voltage of the whole system will, of course, be determined by the sub-station requirements. If, for example, the voltage delivered by alternators at the power house is too low, sub-station attendants will attempt to raise it by cutting out the field resistance of the rotary converter, and thereby drawing leading currents from the power house. This will be shown upon the power factor indicators of the alternators, whereupon the operator at the power house will raise his voltage to meet the sub-station's requirements. The reverse sequence of operation will occur when the direct current voltage is too high.

Step-Down Transformers.—Each transformer is rated at 550 KW., and they are of the air cooled type, motor driven blowers being installed in each sub-station for supplying the necessary air.

The guaranteed efficiencies are as follows:—$\frac{1}{4}$ load, 95·00 per cent.; $\frac{1}{2}$ load, 97·00 per cent.; $\frac{3}{4}$ load, 97·65 per cent.; full load, 97·75 per cent.; 25 per cent. overload, 97·70 per cent.

The overload ratings of the transformers are proportioned to those of the rotary converters, and are as follows:—For a 25 per cent. overload run of 24 hours, the rise in temperature will not exceed 45° C.; under 50 per cent. overload for 2 hours, the rise in temperature will not exceed 50° C., provided the initial temperature is not more than 36° C. above the surrounding air.

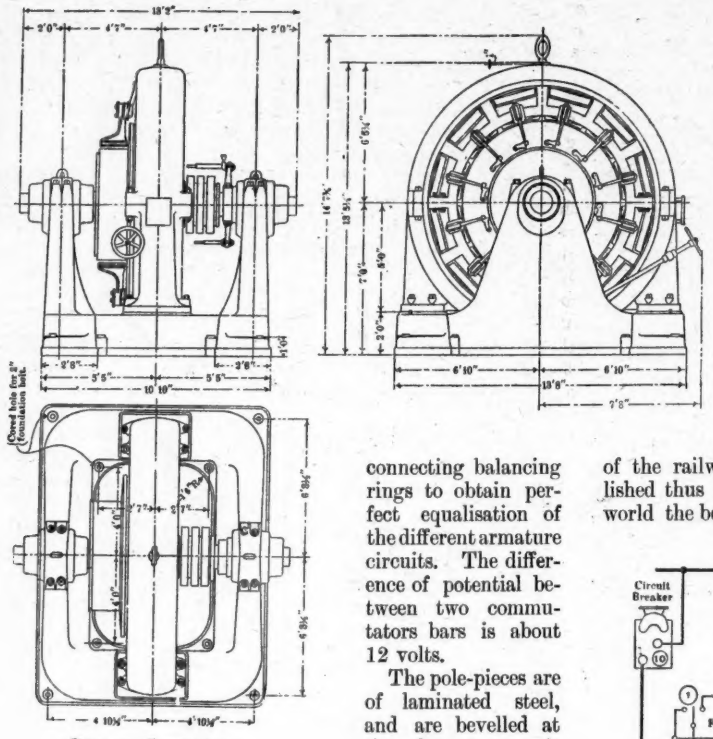
All of these temperatures refer to readings by thermometer.

Rotary Converters.—The rotary converters, as measured by output, are larger than any hitherto constructed, each being capable of delivering in continuous service 1,500 KW. (2,000 E.H.P.), and for a period of several hours 2,250 KW. (3,000 E.H.P.). Each converter is a self-contained unit, the two bearings and the lower half of the field frame being mounted on a common base.

The converter has 12 poles, and consequently when supplied with alternating current at 25 cycles per second, runs at a speed of 250 revolutions per minute. The field will have shunt and series windings, the shunt being arranged for self-excitation. The output of the converter is delivered at a normal potential of 625 volts. The guaranteed efficiences are as follows:—At $\frac{1}{4}$ load, 89·00 per cent.; at $\frac{1}{2}$ load, 93·50 per cent.; at $\frac{3}{4}$ load, 95·25 per cent.; at full load, 95·75 per cent.; at 25 per cent. overload, 96·00 per cent. These efficiences are determined from separate measurements of the losses, only the following being considered:—Armature iron loss, C^2R losses in armature and field windings, rheostat losses, bearing and brush friction, and windage.

The armature winding consists of strip wound coils, formed and insulated before being placed in the slots, and held in position by retaining wedges of hard fibre; there are no bands

on the armature. The insulation of the winding is guaranteed to withstand a puncture test of 3,500 volts alternating E.M.F. applied between conductor and core for a period of one minute. The winding is of the parallel type, forming 12 circuits, and will have a large number of cross-



Rotary Converter.

connecting balancing rings to obtain perfect equalisation of the different armature circuits. The difference of potential between two commutators bars is about 12 volts.

The pole-pieces are of laminated steel, and are bevelled at the edges to permit the use of copper shields around the pole tips, the action of the lips of the shields being to retard any shifting of magnetic fields across the pole face. If a rotary converter hunts, there is a rapid shifting of the field magnetism across the pole face, and this action appears to be cumulative in character. Practice has shown that the copper shields act as a secondary, producing a retarding effect to the shifting magnetism. There is also a liability of pulsation of the entire field magnetism, which tends to be cumulative, and the ring around the pole, acting as a secondary, neutralises this pulsation.

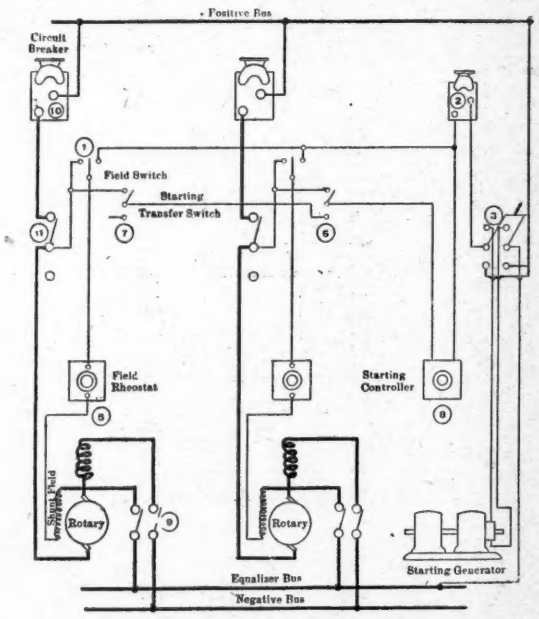
The shunt coil, of comparatively large sized wire, is placed next to the pole tip. The shunt field winding will have sufficient capacity for maintaining 625 volts at the direct current terminals at full load, with a power factor at the alternating current end of 100 per cent. A shunt field rheostat will be provided of sufficient capacity to reduce the potential to 575 volts. In normal operation, at full load, the shunt field will be adjusted for the lower strength, the armature taking a lagging current from the system. The series field will be designed to add to the shunt as the load comes on the rotary converter, and will be sufficient to compound the rotary converter from 575 volts no load to 625 volts full load, with no ohmic drop in the alternating current feeder. Suitable inductances will be placed in each feeder circuit. The series winding consists of copper strip wound on edge, air spaces being provided between the turns of each coil for ventilation.

The fly-wheel effect of these converters is made as small as possible, as the inertia of the revolving armature of a converter tends to force it to act independently of changes in the system, whilst copper shields on its poles tend to force it to promptly follow any changes in the system. Consequently, fly-wheel effect and copper shields may act in opposition to each other, especially where the system is liable to sudden changes of load.

The converters are started by direct currents, a motor-generator starting set being installed for this purpose in each sub-station.

Conclusion.—The trial train has been in operation on the Second Avenue division for some time; it consists of six cars, the forward and rear being motor cars. A future issue of the *Street Railway Journal* will contain an account of the car equipment. The service given by the steam locomotive during the 20 years that the Manhattan Railway has been in existence has, taking it all round, been extremely efficient, but it is perfectly certain that electricity will be able to give better results. For example, electricity will be able to drive six-car trains at higher speeds than the heaviest locomotive of the system can draw five-car trains. In starting from stations the electrically-driven trains will attain maximum speed in much less time than with the present locomotives, and as a result of this more prompt acceleration, combined with power for braking, it will be possible to operate a larger number of trains, thus increasing the ability of the lines to carry passengers; the use of electric power will also eliminate smoke, steam, and cinders, and will in a large measure reduce the noise.

The magnitude of this change over to electricity has necessitated a large amount of pioneer work, and the action of the railway company in allowing the details to be published thus early, and so giving engineers throughout the world the benefit of the costly investigations that have been



DIRECTIONS FOR STARTING ROTARY CONVERTER

Throw 1 to right. Close 2. Close 3 up. Cut out 5. Throw 6 down. Throw 7 up. Cut out 8. Throw 1 to left. Synchronise. Close A.C. Switch. Open 2 and 3. Cut in 8. Throw 7 down. Close 9 and 10 and throw 11 up.

made, is highly commendable. The proprietors of the *Street Railway Journal* are also to be congratulated on their paper being chosen as the medium by which the information is made public.

THE PRICE PATENT FRICTION BRAKE.

The ordinary hand-ratchet brake for tram cars has three principal defects :—

1. It takes a comparatively long time to apply.
2. Its force of application is limited by the strength of the driver.
3. To prevent a constant strain upon the driver when the brake shoes are applied to the wheels, a ratchet and pawl is introduced, which prevents the driver from gauging the amount of braking action.

The Price momentum friction brake was invented to over-

come these disadvantages. It does this entirely successfully without the aid of electricity, compressed air, or any force other than that due to the energy of the moving car.

In the ordinary hand brake, the levers which actuate the brake shoes are moved by a chain which is wound up on the brake spindle.

3. The driver can feel exactly how much slip is taking place in the friction clutch, and consequently can gauge to a nicety the braking action he wishes to apply.

The maximum braking action, as is well known, is when the wheels just do *not slip on* the rails. The driver can obtain this maximum braking action with greater ease,

Fig. 1.

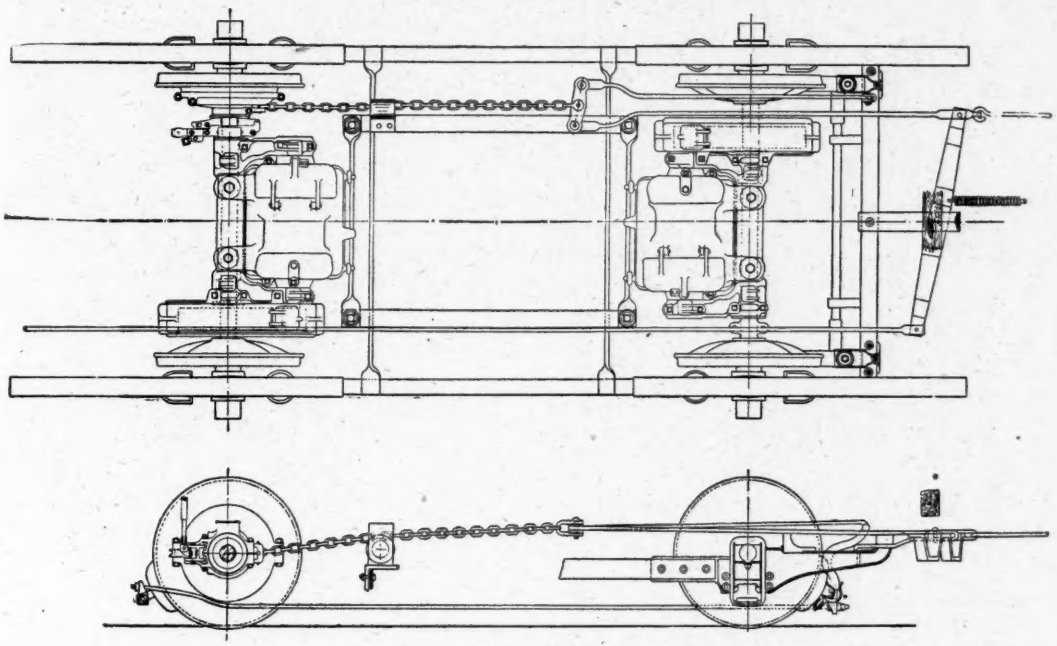


Fig. 2.

In the Price friction brake, the chain is wound upon a sleeve which fits over the axle of the car wheels. This sleeve is thrown in and out of gear with the axle, by means of a friction clutch operated by the driver. This general arrangement is shown in fig. 1.

quicker action, and more certainty than with any other brake.

The brake consists essentially of three parts :—

1. An arrangement of levers for operating the friction clutch.

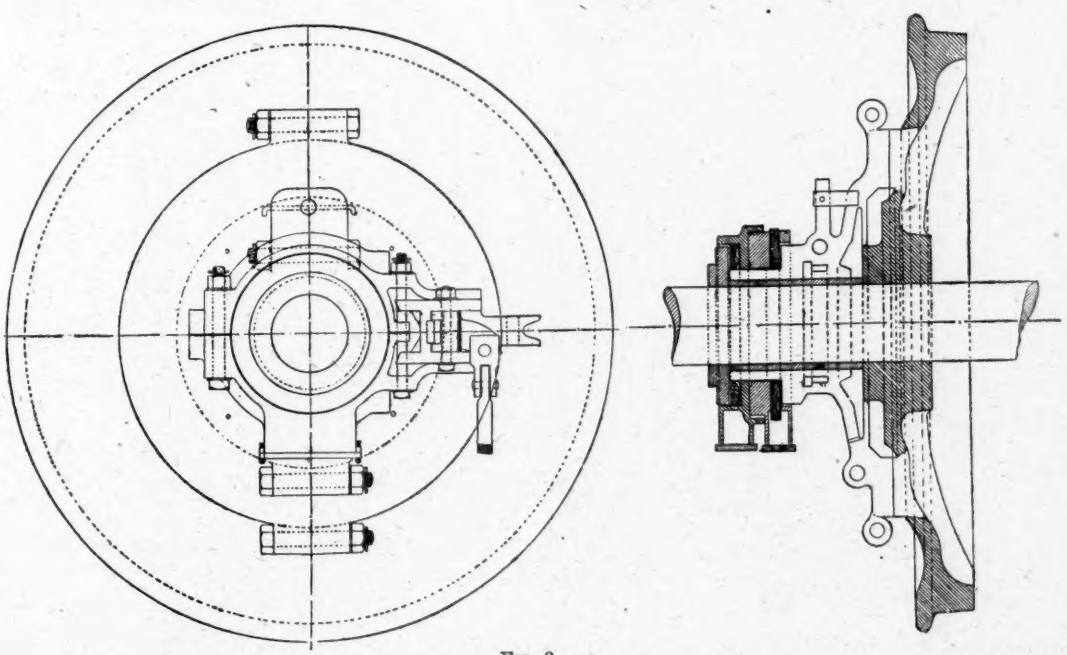


Fig. 3.

The disadvantages of the hand brake as mentioned above, are met as follows :—

1. The Price brake is applied by the moving wheels, and the quicker the wheels are moving, the quicker can it be applied.

2. The force of application is *unlimited.*

2. The friction clutch and barrel for winding the chain upon.

3. The ordinary levers for applying the brake shoes such as are fitted to the ordinary hand brake.

The brake is operated by means of a short handle, which is attached to a staff placed close to the centre of the

dashboard. This handle is detachable and the driver uses the one handle for either end of the car in the same way as a controller handle. To the lower end of the staff under the platform is attached a lever arm which is connected to a wire rope with a spring in it. The rope leads from each platform in as nearly a direct line as possible to a cross-arm lever which is supported by the car body frame and attached to the top of a telescopic rod. The rotation of the telescopic rod moves one of the discs of the friction clutch against the other. Figs. 1 and 2 show the connections.

The friction clutch, fig. 3, consists of two cast-iron discs.

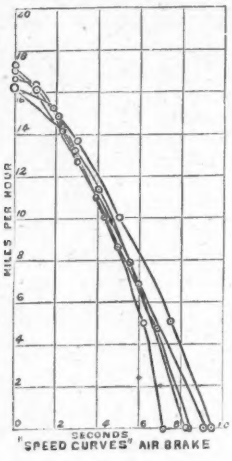


Fig. 4.

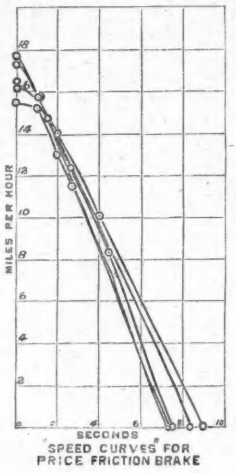


Fig. 5.

One of these discs is cast with a barrel or sleeve which is free to move upon the axle of the car wheels. This barrel is free to move in two ways: first, in the direction of rotation of the axle; second, parallel with the axle. It is moved in the second direction by the operation of the telescopic rod, and when it is thus pressed against the second disc, which is cast on the car wheel, it moves in the first direction.

To lock the friction clutch, and make the barrel move with the wheels, the driver only has to move the handle through a distance of about 2 inches. Then the brake shoes are pressed tighter and tighter against the wheels

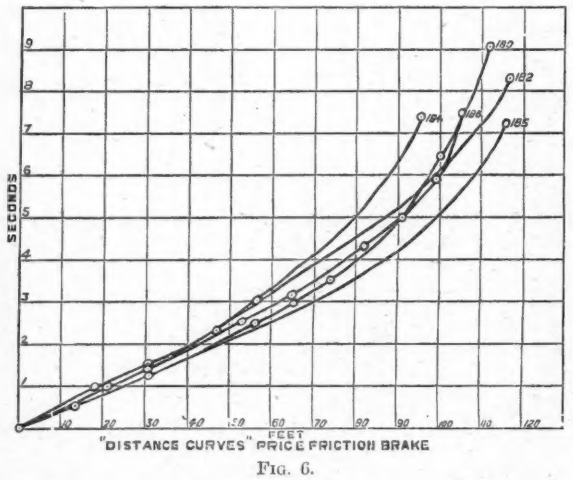


Fig. 6.

until the latter are nearly skidding, when the driver releases his handle a very little bit and allows slip to take place in the friction clutch.

A few of the advantages of this brake are :—

1. The greater the necessity for braking action the quicker the brake shoes are applied.

2. Any amount of braking large or small can be applied quickly and certainty.

3. The maximum braking action can always be obtained with ease and certainty.

4. The wheels and brake shoes last much longer as the braking action is applied with *feeling*.

5. Flats are produced on the wheels only by the most careless driving.

6. If flats should be produced they can by ordinary care be taken off with the brake.

7. The parts of the brake other than the brake shoes last for an indefinite time.

8. The brake can be constructed in various forms to suit light or heavy, single or double cars.

Some very severe tests have lately been carried out in New York on a series of different makes, and the results obtained are most interesting.

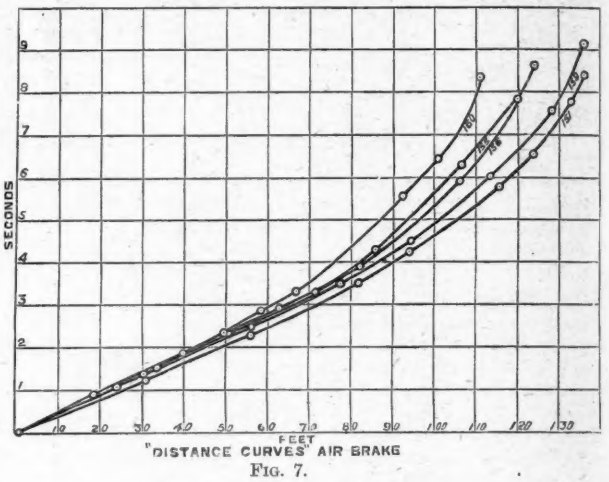


Fig. 7.

These tests were made on the power brakes in use on the Brooklyn Heights Electric Tramways. The brakes tested were one air brake, with axle driven compressor, and two air brakes with motor driven compressors, so as to compare the best known air brake with the Price friction brake. Representatives of the several companies whose apparatus was being tested were present during the tests. Cars were taken from service to one of the depôt shops where the brake rigging was properly adjusted for service conditions, and the necessary instruments installed on the cars, which were then loaded with 10,000 lbs. of iron spikes. The cars tested were mounted on maximum traction trucks.

The speed of cars at any instant was computed from the record of a chronograph revolution recorder (which furnished an exact count of the wheel revolutions), from the time occupied by each revolution and from a record of the signal to put on brakes and the stop of the car. The wheel circumference used was obtained by rolling the car slowly through 10 revolutions, and taking tape measurements of the distance travelled.

When the wheels did not skid, the length of a run computed from the number of revolutions, when checked with the tape measurements, agreed within $\frac{1}{10}$th of 1 per cent. The car was, in each case, made to accelerate very slowly so as to avoid skidding during acceleration.

At speeds less than 18 miles per hour, the several cars were tested on the same track on a down grade of 0·11 per cent. The results of the several tests are shown in Table I.

Table I.—Comparative Tests of Air Brakes and Price Momentum Brake.

Type of brake.	Speed of car in miles per hour when brakes put on.	Distance taken to stop in feet.	Time taken to stop in seconds.	Distance in feet when wheels skidded.	Efficiency of brake if expressed by weight × speed distance.
Air brake axle-driven compressor	16·67	129·4	8·65	6·35	77·6%
Air brake motor-driven compressor	16·65	125·5	8·62	0	79·4%
Air brake motor-driven compressor	16·69	138·6	8·66	3·62	74·6%
Price momentum brake ...	16·68	109·0	7·92	39·3	92·4%

N.B.—The above results were obtained by taking the average of five distinct tests in each case.

Fig. 5 shows the speed curves for the Price momentum friction brake, and fig. 4 shows the corresponding curves plotted from the results obtained with one of the air brakes. The other curves were similar.

Fig. 6 shows the distance and time taken to come to a standstill with the Price friction brake, fig. 7 being similar results with the air brake.

MEASUREMENTS OF DIELECTRIC HYSTERESIS.

By W. E. AYRTON.

Very significant is the wide difference between the results obtained by Mr. Mordey and by Mr. Mather for the County of London cable, Mr. Mordey concluding that over 12 per cent. of the volt-amperes represents real power wasted in that cable, while Mr. Mather finds that this percentage is only a little over 3, and becomes even *less* than 3 when the copper-loss is subtracted from the power given to the cable. Similarly for other long cables respectively of paper and of jute, and for another india-rubber cable, some 15 miles in length, Mr. Mather finds that the percentage is in *each* case also less than 3—a result in close accordance with the results published by Dr. Hoor in the *Electrician* of February 9th for the Buda-Pesth cables, and by Dr. Fleming at the Institution on the 14th inst. for the Ferranti cables.

Now, even if Mr. Mather did not possess his well-known reputation for minute accuracy and keenness in detecting error,* it is absolutely certain that his methods of measuring dielectric hysteresis are correct, seeing that his *three distinct* methods of using the wattmeter gave practically identical results for the same cable. But it may comfort the engineer, who, not unnaturally, may have been terribly alarmed at Mr. Mordey's figures, to know that without any use of wattmeters, motor-generators, or any consideration of angles of lag either between currents, or between professors and engineers, he can test the accuracy of Mr. Mather's results for himself in an *entirely different* way, viz., by considering merely the ammeter and voltmeter readings in the following fig. 1. And that this figure actually represents one of the

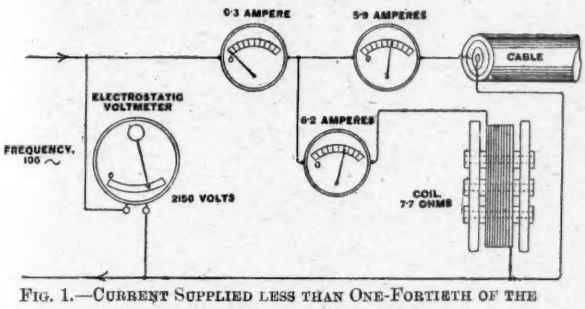


Fig. 1.—Current Supplied less than One-Fortieth of the Sum of Currents in Branches.

many experiments carried out at Prescot on the 12th inst. can be vouched for by various members of the staff of the British Insulated Wire Company, who in succession saw the instruments, illustrated in the figure, and noted their simultaneous readings.

First, the power given to the whole arrangement could have been somewhat less than 2,150 × 0·3, or 645 watts, but could *not possibly have exceeded* that value.

Secondly, the power given to Mr. Mather's coil, the resistance of which at the time was 7·7 ohms (as measured with a Wheatstone bridge shortly before and after the experiment) could have been more than $\overline{6{\cdot}2}^{\,2} \times 7{\cdot}7$, or 296 watts, but could *not possibly have been less* than that value.

Therefore the power given to the cable *could not possibly have exceeded* 645—296, or 349 watts.

The volt-amperes for the cable were obviously 2,150 × 5·9, or 12,685, hence the power factor of the cable *could not have exceeded* $\frac{349}{12{,}685}$, or 0·028.

This value, being an outside limit, is necessarily somewhat higher than the actual value found with the wattmeter, viz., 0·024, but it is very interesting to see that the readings of the ammeter and voltmeter *alone* furnish such a striking confirmation of the accuracy of the result published by Mr. Mather for this particular oiled paper cable.

The readings of the instruments in fig. 1 also prove that I have fulfilled the promise I made at the Institution on January 10th, viz., to construct a coil, *without iron*, which, under Mr. Mordey's conditions as regards capacity of cable, voltage and frequency, should waste far less energy than did his choker, and should cause the current in the supply leads to be only a small fraction of the least current which he was able to obtain, viz., 1·6 amperes. For making the calculations of the exact size, shape, and number of windings of wire to use with this ironless coil, weighing only 91 lbs. as compared with 260 lbs., the weight of Mr. Mordey's choker, as well as for superintending its actual construction, I am indebted to Mr. Mather's wonted ability and energy.

Now is it equally possible to apply a check test of the inherent *in*-accuracy of Mr. Mordey's method of testing, as distinct from the irresistible conclusion that his value for the dielectric hysteresis loss in the County of London cable is more than 400 per cent. as great as it should be? I think it is, in spite of the fact that his paper is absolutely silent regarding the method of testing which he employed, beyond the bare fact that a "Thomson recording wattmeter" was used—a fact, however, which Mr. Sparks appears to dissent from.

At any rate, whatever was the type of energy-meter used, we are at last told that it revolved *backwards*—"I see Prof. Ayrton is smiling," said Mr. Sparks, in the discussion last week.—Yes! because, although in the paper there is not a single word about this retrograde result of paramount importance in the estimation of the power-factor of a cable, some of us surmised, directly the proof of Mr. Mordey's paper reached us, and before it was read, that the meter used in his measurements actually did run *backwards* when applied to the cable alone. And, consequently, Mr. Evershed, Mr. Mather, Mr. Duddell, and myself, considered independently what was meant by an energy-meter running backwards. And on comparing notes we found that we had arrived at a very interesting result which gives the *maximum value of the power-factor of the cable without even knowing at what particular speed the energy-meter may have retrogressed.*

The result—which has been tested experimentally by my students—and which may be quite easily worked out by anyone as soon as the idea is given him, is as follows:—Let h and o be the self-induction, in henries, and the resistance, in ohms, of the pressure circuit of a Thomson energy-meter, that is, of the armature, starting coil, and non-inductive resistance, and let p equal $2\pi \times$ frequency, then such a meter attached to a cable, as illustrated in fig. 2, and

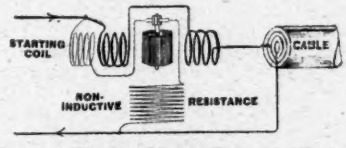


Fig. 2.—Thomson Energy-Meter Rotating Backwards when Cable has Small Dielectric Hysteresis.

supplied with current following the sine law *will rotate forwards, or will not budge, or will rotate backwards, according as the true power-factor of the cable exceeds, or is equal to, or is less than,* $\frac{h\,p}{o}$.

Hence, without knowing anything about the speed at which the energy-meter runs backwards, or anything about the voltage applied to the cable, or anything about the current flowing into it, the mere fact that the meter *does* run backwards proves, with sine waves, that the ratio of the *true* power to the volt-amperes, that is the *true*

power-factor of the cable, is *less* than $\frac{h\,p}{o}$.

* Twenty years ago Mr. Mather was attending some lectures I was giving, and I borrowed his note book at that time to see the results of some experiment. In it I found written:—"Prof. Ayrton says . . . . but I think he is wrong because . . . . ." This critical power and independence of character have aided others like myself many many times during this 20 years.

Having arrived at this conclusion, measurements were at once made on four modern specimens of Thomson energy meters, for the loan of three of which I am indebted to the British Thomson-Houston Company. And the following were the results obtained :—

No. 62,695	$h = 0{\cdot}25$ henry	$o = 3{,}785$ ohms.
,, 230,355	$h = 0{\cdot}24$,,	$o = 2{,}100$,,
,, 230,375	$h = 0{\cdot}26$,,	$o = 3{,}060$,,
,, 230,380	$h = 0{\cdot}22$,,	$o = 3{,}095$,,

Hence, if the meter illustrated in fig. 2 be the first one in this list, for example, and if, when a sine wave current of 100 ~ be applied, the meter be found to run *backwards*, then, no matter at what speed it may run backwards, or what may be the value of the voltage applied to the cable, or the current flowing into it, the *true*

$$\text{power-factor of the cable is } \textit{less} \text{ than } \frac{0{\cdot}25 \times 628}{3{,}785},$$

i.e., is *less* than 0·042.

And this limiting maximum value, curiously enough, is not so very much greater than the actual value found by Mr. Mather for this County of London cable, viz., 0·029.

Further, it can be proved that the *faster* the energy-meter is found to run *backwards* the *smaller* is the *true* power-factor of the cable, that is, the less is it compared with this limiting value 0·042.

If instead of an energy meter, a simple wattmeter be employed, then for running forwards, staying at rest and running backwards, we have merely to substitute a positive deflection, deflection nought, and a negative deflection. So that with a simple wattmeter applied to a cable which is supplied with a sine wave current, the wattmeter will give a *negative* deflection (as obtained, for example, by Dr. Sumpner), when the *true*

$$\text{power-factor of the cable is } \textit{less} \text{ than } \frac{h\,p}{o},$$

h and o now referring to the fine wire circuit of the wattmeter.

Very probably, however, Mr. Mordey employed in addition some form of step-down transformer, since the preceding energy-meters can only be used directly with pressures not exceeding something like 200 volts, and as a matter of fact it was at 100 volts that the experiments of running backwards were made by my students. With such a combination of transformer and Thomson energy-meter, the effective resistance and inductance of the transformer must, of course, be included in the preceding calculation. But whether such a transformer was actually employed in the tests which supplied Mr. Mordey with his figure 0·124, or what was the size, shape, resistance, inductance, &c., of that transformer, the gods alone know.

REVIEWS.

American Telephone Practice. By Kempster B. Miller. New York : *American Electrician* Company, 120, Liberty Street.

(*Continued from page* 229.)

Chapter XV. can scarcely be regarded as complete. Purporting to treat of listening and ringing apparatus, it discusses a few existing systems, but makes no mention of the devices of either the Western Electric Company, or Ericsson.

Chapter XVI. has "Self-restoring Switchboard Drops" for its subject, and deals with two types of self-restoring indicators, one electrical, the other mechanical. The former type being well known, it need not be discussed ; but the latter, which is less familiar, possesses features deserving of notice. The line jack and the indicator are mounted together, the indicator being immediately behind the jack and end-on. The shutter is held up by a long lever in front of the jack with its points of suspension slightly above the latter. A current through the indicator attracts the armature and releases the shutter which falls immediately in front of the jack. A connection to the line is effected by the operator inserting her peg directly against the fallen shutter, and in so doing mechanically restoring the shutter to its nominal position. This arrangement of indicator and jack, besides effecting a saving of battery power, possesses the great advantage of sparing the operator the mental effort of associating a particular indicator with a particular jack, and thus increases the speed of operating.

Switchboards for small exchanges receive a short notice in Chapter XVII.

Chapter XVIII. is devoted to "Lamp Signal Switchboards," and incidentally the author puts forward the claim of lamps to pre-eminence amongst indicators, remarking : "They are capable of attracting the attention of an operator with more certainty than the ordinary shutter ; they are entirely free from mechanical complication ; they are more compact than the simplest electro-mechanical signal ; they are entirely automatic in their operation, being always restored to their normal condition by a cessation of the current through them ; by the use of various coloured glass in front of them they may be used in the same board as indicating different kinds of information ; they are easily replaced when destroyed ; and they are cheaper than other forms of indicators." Concerning the life of lamp indicators some interesting information recently given by Mr. A. V. Abbott, of Chicago, is quoted. It would appear from tests made by that gentleman that the active life of an average lamp in general switchboard service is about 1,200 hours.

The multiple switchboard is explained in Chapter XIX., and the same chapter contains a short explanation of the Kellogg divided board.

Chapter XX., a very interesting one, describes several transfer systems. One of these, the Express, installed in a San Francisco exchange with 6,000 subscribers, is noticed at great length, and it is shown that even in exchanges of the size indicated, an efficient service can be secured without multiplying subscribers' lines. But it is unfortunate that the author does not attempt a comparison between this and one of the modern multiple systems in respect of first cost, efficiency, cost of maintenance, and of operating. From the mere fact that every transaction entails the employment of three operators, it is obvious that the rate of operating must be considerably slower, and the cost of operating very much higher, than on a multiple system.

Chapter XXI. on common battery systems, is a valuable contribution to telephone literature, in view of the fact that common battery systems are rapidly ousting all others. Various systems are described, including those of Stone, Dean, Hayes, and Scribner. The Dean system does not appear to have made much headway, due, in the author's opinion, to the greater simplicity of the other systems. And yet, although the Dean system has not been a success, a good deal of space is devoted to its description, while no reference is made to the Western Electric Company's central battery system of to-day. It is disappointing that in a book of such recent publication the latest arrangement of the central battery system employed by this company is not accorded even a short notice, more especially since it is achieving such universal success. Besides, it is a pity that the writer confines his description to the principle of the system, and makes no attempt to describe the switchboard peculiar to any common battery installation.

Chapter XXII., on House Systems, contains nothing calling for remark.

Chapter XXIII. is an excellent one on Protective Devices, and the information it gives concerning protectors, fuses, and heat coils is the most up-to-date we have seen on the subject.

Chapter XXIV. is a valuable contribution on the subject of Distribution Frames.

Chapters XXV. to XXVIII. are devoted to the description of four systems of "Party" lines. These party lines might be divided into two classes, namely, "secret" and "non-secret," but the author apparently prefers to classify them according to the method of call, and consequently the four systems are described as "non-selective," "step-by-step selective ringing," "selective signalling by strength and polarity," and "harmonic systems of selective signalling." Lock-out or secret systems are somewhat briefly treated, and it is noticeable that the author does not commit himself on the point of their efficiency. It is admitted by Mr. Miller that a relatively large number of the systems of party line working which he describes are merely of historical value, nevertheless 50 pages are devoted to this subject, whilst little more than half this space covers the whole field of so important a subject as the central battery system.

The space allotted to each might advantageously be reversed in future editions.

Chapters XXIX. to XXXIII. are, in our opinion, the least satisfactory portion of the work.

Chapter XXIX., on "Wire for Telephone Use," contains instructive remarks on gauges and ganging, and reproduce tables and a specification for copper wire, the latter containing two formulæ not explainable by the context. Surely the statement in this chapter that, in America, galvanised iron wire lasts on an average from four to six years must be erroneous; in this country the average life ranges between 12 and 15 years.

Chapter XXX., on "Pole Line Construction," opens with a statement that, according to Maver, the average life of a Norwegian pine is six years. If this be correct, and heavy pole lines, such as are represented in fig. 291, carrying over 100 wires, have to be renewed once in five years, then it is time the process of creosoting was introduced into America, Mr. Miller remarks that "in Europe the process termed creosoting *is meeting* (the italics are ours) with great favour for preserving telephone and telegraph poles." The United Kingdom is generally embraced in the Old World Continent referred to, and can Mr. Miller be unaware of the fact that creosoting has been in vogue in this country for quite 40 years, and with such success, that 20 years represents the average life of timber treated with creosote—not crude petroleum, as Mr. Miller designates the preservative used for the process? We know of poles still in use which were creosoted in 1870 and 1872.

Dealing with the question of the number of poles to the mile, the author says that "in Europe the common practice is to use as few as 20 poles to the mile," and he proceeds to say that in America the best practice dictates the use of 40 to 50 poles to the mile. Either Mr. Miller is woefully ignorant of English practice, or he does not include this country in Europe. It is a pity the author of a work ostensibly on American telephone practice, quotes European practice so frequently, albeit erroneously.

A description of different forms of dry joints, which were long ago discarded in this country, and the entire absence of any reference to the well-known (and universally used in this country) soldered Britannia joint are sufficient in themselves to place the American behind English line construction.

The American methods of pole-staying leave much to be desired; and if our trans-Atlantic cousins can find space to spread the stays as shown in figs. 293, 294 and 297, then the English telephone engineers might well envy them the space, but we would not counsel them to copy the methods.

The illustrations throughout this chapter are poor indeed, and the author might with advantage take for his model the drawings in English works on kindred subjects.

Since it is in this chapter that the use of what in this country are termed Americanisms is most noticeable, we may appropriately refer to them at this stage. Expressive terms we do not object to, even if they be not too elegant, but we think their adoption in supersession of approved terms should not be carried to excess. We offer no objection, for example, to a "stay" being called a "guy," to a "pole-trestle" being called a "pole-back," even to a "draw-tongs" being called a "come-along," but we do protest against a "pole-support" being termed a "dead man" when it involves such an expression as the following:—"The small end of the pole is raised higher and the dead men placed under it, while the men obtain another hold."

(To be continued.)

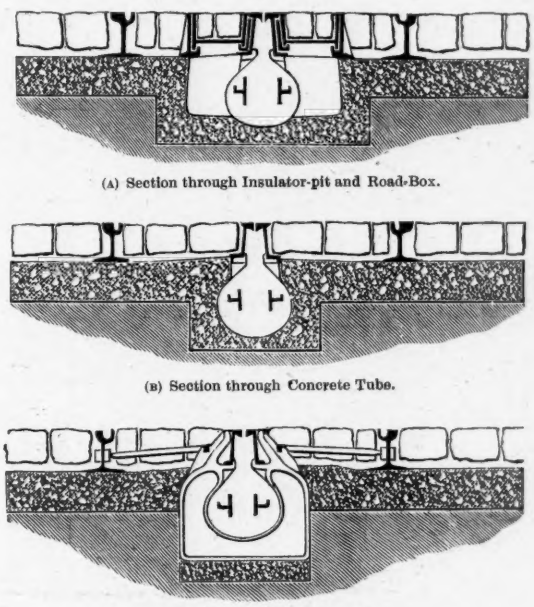
LONDON COUNTY COUNCIL TRAMWAYS.

A meeting of County and Borough Councillors and others interested in the London tramway question was held, as we briefly stated in our last issue, at the Camberwell depôt of the L.C.C. tramways, to inspect the experimental section of Westinghouse conduit tramway laid down by the Council, and the type of conduit devised by Prof. Kennedy. Afterwards Mr. Dickinson, chairman of the Council, Mr. Benn, chairman of the Highways Committee, and others addressed the meeting, and pointed out the benefits that would ensue from the adoption of electric traction over the London system of tramways.

Below we give sections of the L.C.C. conduit, as well as of various electric and cable conduits which have already been put in operation at home and abroad. The following description of the L.C.C. system is condensed from a brochure distributed at the meeting, from which also the sectional views on this page were derived.

The track will be double, as at present, 4 feet 8½ inches gauge, with steel girder rails weighing 102 lbs. per yard. The steel slot rails weigh 50 lbs. per yard, and the slot is ¾ inch wide.

The slot rails are bolted to the jaws of the yoke, and further secured by wooden wedges; the yokes are 5 feet apart. The conduit will be made of best Portland cement



(A) Section through Insulator-pit and Road-Box.

(B) Section through Concrete Tube.

(C) Section at Yoke.

Fig. 1.—Sections of the L.C.C. Conduit designed by Professor Kennedy.

concrete (5 to 1), with depth inside of 1 foot 9½ inches, outside, 2 feet 1½ inches, and an internal width of about 1 foot 2 inches. Under the track rails the concrete will be 8 inches thick.

The conductors are soft steel tees, weighing 23 lbs. per yard, and are carried by insulators at 15 feet intervals. Access from the street to every insulator is given by a cast-iron box, shown on section A, with an opening 1 foot square. Larger openings are provided over the drain pits, and over the section insulators, which last occur at intervals of not more than half a mile.

Both conductors will be insulated throughout, but automatic cut-outs and change-over switches are provided, by means of which, in the event of a persistent fault occurring on the positive in any section, the polarity can be reversed, so as to throw the fault on the negative pole until the stoppage of the traffic at night allows of its removal. The working pressure will be 500 volts, current being generated in a station at Camberwell Green for the Tooting lines, *i.e.*, between Westminster Bridge and Tooting, Kennington Gate and Blackfriars Road, and St. George's Circus and Waterloo Road. There will also be a sub-station at Balham. Double-decked bogie cars, carrying up to 70 passengers each, will be used, with a maximum speed of 10 miles per hour within 4 miles of Charing Cross. A main generating station for the whole of the Council's tramways south of the Thames is to be erected at the Camberwell depôt, and it is hoped that actual running will be commenced in about 18 months.

As we remarked last week, Prof. Kennedy's design differs from existing electrical conduits chiefly in the form of the yoke, and in the method of supporting the conductors. In all the more important electric conduit systems with the slot in the centre of the track, the yoke has been carried right

across the track, so as to bind the running rails and the slot rails rigidly together; but in the L.C.C. design, the running rails are only tied to the yokes. This feature will doubtless meet with severe criticism; but in discussing the matter, due attention should be paid to the conditions in each case.

In the original New York lines, a rigid construction was absolutely indispensable, owing to the then unsettled and defective state of the roadway. Conduits in other towns were constructed on the same lines, in some cases for precisely similar reasons, in others by force of example. But is this really necessary in London? Where else can be found such excellent roads, based on the soundest foundations, and efficiently drained? Moreover, what experience has already been acquired in conduit practice under such conditions? The answer, obviously, is to be sought in cable conduit practice. One of our figures shows the system adopted both at Edinburgh, and, very aptly, at Brixton, where it has been running for years. It will be seen that the L.C.C. yoke is of very similar type to those used for the cable tramways, a special feature being the continuation of the yoke to the top of the slot rail, which therefore is not dependent entirely upon the lower flange for a rigid support. On the other hand, the use of wooden wedges to secure the slot rails in position appears to be very objectionable. It may be said that railway practice justifies their adoption, but this is not a fair parallel. Railway chairs are readily accessible at all times; but how will these wedges be tightened, buried as they are under the pavement, when they work loose—as they surely will? The saving in space occupied by the type of yoke proposed will undoubtedly be of great importance, considering the difficulties likely to be met with in London streets, and no doubt this has weighed largely in influencing Prof. Kennedy's decision.

The apparent stint of concrete round and under the yokes ought to be remedied; in the drawing no concrete at all is shown at the sides, but we trust that this is a mere oversight. The addition of a drain pipe beneath the conduit, as in the cable system, would also appear to be an advantage, though considerations of space must be taken into account.

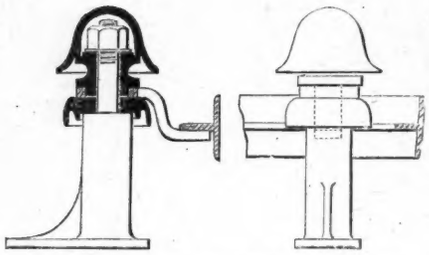


Fig. 2.—Insulating Supports used on the L.C.C. System.

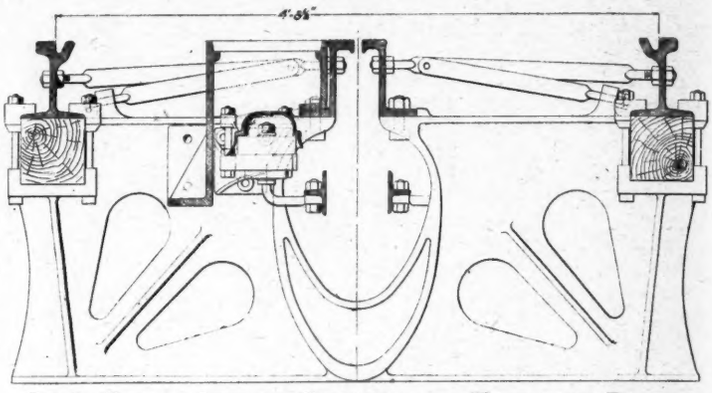


Fig. 3.—Yoke and Insulators Employed on the Westinghouse Electric Conduit System Operating at the L.C.C. Camberwell Depot.

The square corners of the base of the yoke were added for the purpose of supporting the experimental line above the ground at the Tramways Exhibition last year, and do not occur on the Standard Westinghouse Yoke, which is of heavier construction than that illustrated in this drawing.

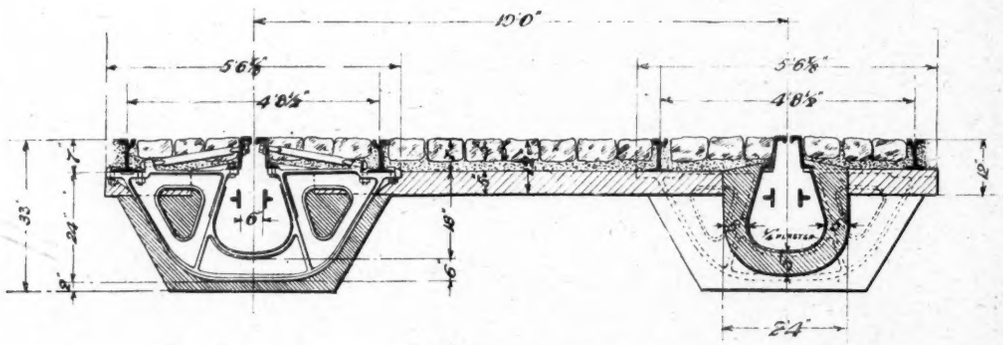


Fig. 4.—Sections of the Electric Conduits used at Washington and Paris.

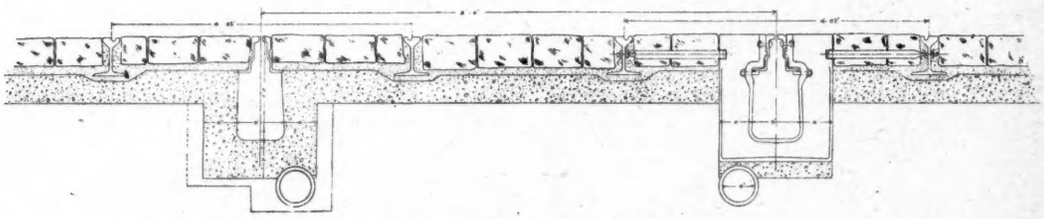


Fig. 5.—Sections of Brixton Cable Conduit.

The Edinburgh Conduit is almost identical.

Probably the feature around which the most adverse criticism will centre is the method of supporting the insulators. These in themselves are designed on liberal and substantial lines, and to them we do not take exception; but we feel convinced that it will never do to support them from below. In the model at the Camberwell depôt the insulator pedestals are set in the concrete in chambers out of the direct run of the conduit, but raised only a few inches above the bottom of the latter. Consequently these recesses form admirable opportunities for the lodgment of mud and dust, of both of which there is no lack in London. The experience gained in other towns is here directly applicable; in all others a hanger has been preferred to a pedestal—not without trying the latter, however, as, for instance, in the early days of the New York lines. This is such an important matter that we sincerely trust that it will be reconsidered before it is too late.

In conclusion, we feel bound to add that the general impression left upon our mind by a careful examination of the model was—that the design was in several respects wanting in finish. Mistakes cannot be rectified except at enormous cost, once the conduit is underground, and we have drawn attention to those points which appear to us to demand the most attentive consideration while there is time to avoid error.

CORRESPONDENCE.

"Hoanki."

I have pleasure in enclosing herewith a specification for goods to be supplied to the Imperial Japanese Government translated by one of our clerks who has but small knowledge of the technical language of his country. The result is, in some ways, very creditable, but it is very amusing. Perhaps your readers may be able to understand what is desired. We have been able by Herculean struggles to grasp the meaning approximately, but cannot get a meaning for the word "Hoanki."

With reference to a recent notice in your columns with regard to the number of power stations, &c., in Japan, I am glad to be able to give you the number of electric light companies at work, viz., 62. This number is taken from the *Denkilomo*, the leading electrical paper in Japan, which also states the number of arc lamps in use as 85, and of incandescent lamps as 165,952. The total paid up capital involved is £1,005,050. These figures only apply to *public companies*. The number of electric tramway companies is not known to us exactly, but the number certainly does not reach to more than 25, if that. With regard to stations for the supply of electric power solely, and of a public nature, we do not know of any. There are, of course, a large number of factories where the power used is electricity, but is generated for private use.

F. S. Shaw.

Yokohama, *January 11th*, 1901.

Specification for Some Apparatus for Solid Back Telephone Apparatus.

Specification for "Hoanki."

1. To be quite strongly made following to undermentioned particulars:—
2. Metal part of this article must not have tear, rust, defect, &c.
3. Base to be flat and smooth magnet which has no tear, defect, &c. Size to be 182 × 97 mm., and width 21 mm. at centre.
4. Fuse to be flat and wrapped with asbestos perfectly. Length to be 75 mm.
5. Heating coil's diameter is 0·173 mm. (S.W.G. 37), and to be copper wire or platinum wire, and wrapped with silk. To be able to twist together with copper wire and to solder. Resistance to be 20—26 ohms at 15° C.
6. Fuse and heating wire must work easily by the marked current within 15 seconds, but only fuse not work by the weaker current than marked current.
7. Fuse and heating coil cup to be had an electrical joint having soldered perfectly which is dissolvable at the temperature over 100° C. Heating coil and cup to be soldered perfectly which is dissolvable at the temperature between 50—70° C.
8. Fuse and heating coil are to have equal type as picture, and to be laid into the vulcanised fibre pipe which has no tear or defect. Metal works of before and behind and middle part, are to be had electrical joint having soldered which melts at the temperature over 100° C.
9. Round pole which pushes heating coil cup by pressure of "snaping wire" to be made of glass. Size to be 23 × 1½ mm. (length diameter).
10. One set of carbon consisting of two carbon boards and one piece mica for barbed. One has a ditch, and other has combined metal centre which is dissolvable at the temperature of 80°. Its quality must be quite strong.
11. Wrapping of barbed is to be yellow copper and to be thick and thin though all part.

Belt-Driven v. Direct-Coupled Electric Lifts.

Will you allow us to return to the above subject in view of another communication appearing in your current issue.

The writer appears to have had an unfortunate experience of direct-coupled machines with reversing motors, but we gather that this happened more than two years ago, and in things electrical that is a long time.

We think, however, that even at that date something much better was obtainable than your contributor had the good fortune to find. In any case, it seems undesirable to condemn an entire type for the faults of some isolated bad examples, and to revert to an antiquated and wasteful combination as the only issue.

Respecting cost of working:—You were good enough to print a few weeks back a statement of results, obtained with our direct-coupled machines: we have worked out on the same basis the current consumption for a direct-coupled machine of equal power with the belt machine noticed last week, and comparing this with the results given, charging the belt machine with current for idle time only equal to running time, the running costs work out at a trifle under two to one in favour of direct coupling.

Turning now to the alleged difficulty with the reversing switch of the direct machine, is it really unavoidable?

Your contributor speaks of "this type of switch constantly giving trouble," of "constant renewal of contacts," and "the labour item became prohibitive."

Here is another view; we can point to direct-coupled machines which have run from two to three years without the renewal of a single contact.

Farther on we are told of 50 to 60 double trips being made *during the last hour of the day* (our italics), and that "this heavy duty would have a most distressing effect on the reversing switch had we a direct-driven hoist."

To this we reply that we have a considerable number of machines performing this distressing duty, not merely through the "last hour," but every hour of the day. These machines are carrying passengers in busy blocks of City offices, and in some cases the circuit is broken 600 times per day.

The first of these particular machines started about two years and six months ago, but no new contacts have yet been required.

The true conclusion to be drawn is, not that direct-coupled machines are troublesome, but that they, like all other machines, must be suitably designed for the purpose in view; and secondly, that the machines which so worried your contributor, were improperly constructed.

In conclusion, we would like to say that as we manufacture both types, we have no commercial bias in the matter, and merely write under the conviction that the application of electrical power to all purposes, can only be retarded by the advocacy of imperfect and uneconomical types.

A. Smith & Stevens.

Standardisation of Commutator Bars.

Having recently established a drop forging plant upon American lines, might we trespass upon your space with a few remarks as to the possible utility of the same to electrical engineers.

Many years ago we commenced the manufacture of hard-drawn copper bars for commutators, to dimensions which were specified to us from time to time by dynamo builders, and by degrees we accumulated a large stock of tools for various sizes. A few years ago we thought it would be advisable to have these tools catalogued and arranged according to the description of commutator for which they were suitable, the result being a small book which you were good enough to notice, and which is known to many of your readers, but in spite of the large number of sizes thus shown we still have to make new tools for about half the orders we receive, so that the number has now reached something like 3,000 and is still increasing. The reason for this appears to be partly that designers have a great variety of ideas, and partly that at the commencement there was no system of classification, and a good many of the dimensions were calculated neither with perfect accuracy nor to produce a commutator of any standard size. The cost of making tools for drawn bars is not very heavy, and does not add much to their price, except in the case of small quantities, so that there has not been much loss to the trade except, perhaps, in the matter of deliveries of small lots for repairs, &c. In the case of drop forged bars the cost of tools is exceedingly heavy, although the bars themselves, if made in large quantities, are considerably cheaper than drawn bars, when the small amount of work to be done upon them by the

dynamo builder is considered—the lugs being forged on and the ends shaped. The pattern, however, cannot be varied in length or in any other particular without making another set of dies. So that for the advantage in cost to be obtained it is necessary that bars should be bought either in very large lots or of standard sizes. We are given to understand that in America standardising is carried to such an extent that a comparatively small number of patterns answer for the whole trade, and besides the considerable saving in cost, there is the convenience that standard sizes can be kept in stock and despatched on receipt of a telegram. We should be very pleased if the dynamo builders in this country could see their way to suggesting a set of standard patterns while the industry is new, rather than letting a miscellaneous selection grow up, as has been the case with drawn bars.

Thos. Bolton & Sons.

P.S.—We think the same might apply to other things besides commutator bars.

[The importance of this matter, which vitally affects the cost of the most expensive part of a dynamo, cannot be too strongly insisted upon. We cordially endorse our correspondents' suggestion that, in the best interests of the industry, the opportunity should be seized to standardise, as far as is possible and compatible with efficiency, not only commutator bars, but also all such apparatus and accessories as lend themselves to standardisation.

Referring more particularly to commutators, the American system is about to be introduced into this country by American firms, and if British dynamo builders are to be in the best position to compete with them, prompt action is necessary.

Cannot a Committee be apppointed by the Institution of Electrical Engineers, to formulate proposals on the whole question of standardisation, as was done in the case of frequency?—Eds. Elec. Rev.]

Re Tooting Bec Asylum Tenders.

It is very interesting to read the letter appearing in your last issue respecting the tenders for above work. I think it might be taken for granted, that, to a contractor, the job was worth, at the very least, the figure representing the consulting engineer's estimate, and it is fairly evident that someone will have made a bargain (?) when the work has been completed.

There is not the shadow of doubt that a large number of contractors exercise methods of estimating which are primitive in the extreme, and generally are not alarmed until the prime cost begins to assume gigantic proportions, and steadily and persistently overflows until even the high-water mark of allowances and contingencies becomes submerged, and actual losses open up a delightful view of possibilities. One man tenders with that charming simplicity mentioned, "he knew what asylum buildings were like—he had done an asylum before." It would be very interesting to learn how this worthy had "done" an asylum. It opens up ways for reflection. Phil May would have replied "come inside." A manufacturer was in my office the night previous to the day these tenders had to be in, and asked leave to use the telephone in order to quote a man for some material necessary to this particular work. After talking a little the manufacturer informed me, that during the conversation, this man had asked his advice about tendering, and as neither the plans nor site had been studied, would like his, the manufacturer's, advice whether he would be right in tendering upon a basis of 30s. per light. The manufacturer knowing nothing of the job appealed to me, and my advice was prompt though courteous. The manufacturer's reply was given in guarded terms. One wonders whether this man had "done an asylum." As your correspondent states, it is regrettable that prices vary so much, but if cutting contractors are made to know that the consultants' estimate figures will be sure to be published, in time estimates will appear bearing the stamp of experience and consideration.

Writer of the First Letter.

Institution of Electrical Engineers.

The difficulty that occurred to everyone who heard the late discussion at the meeting of the Institution of Electrical Engineers, and the applause which greeted the reference, not only to "Professors," but to "rows of them," was the apparent inability of the meeting to understand the simple question before them.

Mr. Mordey had described one solitary test made on one solitary cable. He gave no details of how it was carried out, or what steps he had taken to avoid obvious risk of error. From this single result he drew generalised conclusions, which he apparently intended us to apply to any cable with any dielectric.

Even if he had taken all the possible precautions to ensure accuracy, it would have been unwise to apply his result to another india-rubber cable working at any electric pressure, and it would have been impossible without further test to have applied it to (for instance) a paper cable.

Is it unfair to describe his action in laying so crude a compilation, with conclusions for the guidance of engineers, based on so superficial an investigation, before a scientific engineering society as (to say the least) very uncomplimentary to the intelligence of his audience? May we not also regard with some indignation his apparent attempt to secure applause by his remarks about "engineers and professors?"

Again, do those who may think that Mr. Mordey has done a service to science by extracting from Prof. Ayrton the result of the valuable investigations, which were laid before the meeting on Thursday, consider that the *rôle* of the engineers is to put forward wholly erroneous conclusions for professors to expose?

M.I.E.E.

Might I trespass on your valuable space to ventilate a grievance from which a good many members suffer?

On Thursday last I visited the Institution for the first time for some two years, to hear the adjourned discussion on Mr. Mordey's paper; and was not a little surprised to find that the lecture theatre still remained nothing better than an arena for baiting professors.

These verbal duels are, doubtless, interesting to the principals, but to many of the audience they are an absurd waste of valuable time.

Many of the professorial remarks made during the evening might have been left unsaid without in any way detracing from the practical value of the discussion. With all respect to our leading professors, who no doubt have more science per cubic centimetre of brain than a mere practical electrical engineer, it seems advisable, in my humble opinion, to let the latter have his say in the discussion, and enrich the *Journal* with the remarks of the former, that we may read and digest them, or otherwise, at our leisure.

I could name two or three gentlemen who could have given us valuable information, but who were not allowed even to "get under way." The wrangles that the discussions tend to degenerate into do not encourage people to take pains with experiments for the sake of demonstrating results before the Institution, and some incentive other than professorial heckling will have to be devised if we are in any way to profit by meetings such as the one in question.

One of the Audience.

February 17th, 1901.

Dielectric Hysteresis Losses in Long Cables.

In the tests made at Silvertown and Prescot on dielectric losses, instead of arranging all the drums of cable merely in series, we tapped the inner and outer conductors at several points along the length, so as to reduce the copper loss in the cable to a negligible amount, and thus get a more exact value of the hysteresis loss.

In testing the laid cable of the County of London Company on Thursday, the 14th inst., it was, of course, impossible to reduce the copper loss in the way mentioned above, and the number given by me at the meeting of the Institution of Electrical Engineers for the power factor of that cable, viz., 0·033, included the copper loss. Making, how-

ever, the necessary corrections for the copper losses in cable, leads, and instruments, the power factor for dielectric hysteresis above is, I find, reduced to as low a value as 0·029—a number in close approximation to the 0·028 which we obtained at Silvertown on February 1st on another long india-rubber cable.

T. Mather.

Central Technical College,
February 19th, 1901.

BUSINESS NOTES.

Electrical Wares Exported.

Week ending Feb. 20th, 1900.		Week ending Feb. 19th, 1901.	
Adelaide. Teleg. apprts.	Value £300	Alexandria	Value £154
Alexandria	26	„ Teleg. wire ..	145
Boca	269	Amsterdam	204
Bombay	70	Bangkok	41
Buenos Ayres	85	Boca. Teleg. mat.	543
Calcutta	218	Bombay	135
Christiania. Teleg. wire ..	48	Brisbane	100
Colombo. Teleg. mat.	467	„ Te'eph. mat. ..	150
Constantinople	48	Buenos Ayres. Teleg mat. ..	300
Copenhagen. Teleg. cable ..	35	„ Teleph. mat. ..	250
„ Teleg. mat. ..	170	Calcutta	3,1 4
Durban	808	„ Teleg. wire	176
„ Teleg. mat.	337	Cape Town	1,410
East London	59	Christchurch	17
Fremantle	54	Christiania. Teleg. wire ..	133
Hamburg	360	Colombo	120
Hong Kong	810	Copenhagen. Teleg. wire ..	18
„ Teleg. mat. ..	43	Durban	1,391
Kobe	86	Fremantle. Teleph. mat. ..	444
Nagasaki. Teleg. cable ..	26,750	Flushing	14
Ostend	52	Genoa	72
Penang. Teleg. mat. ..	287	Gibraltar	23
Perth. Teleg. cable	402	Hamburg. Teleg. mat.	676
Port Said	57	Hong Kong	112
Shanghai	309	Launceston	100
Singapore	87	Malta	16
„ Teleg. cable ..	21,000	Melbourne	502
Stockholm. Teleg. wire ..	73	„ Teleg. cable ..	1,057
Sydney	230	Nagasaki	80
Townsville. Telephones ..	98	Otago	204
Wellington	296	Piræus. Teleg. mat.	40
Yokohama	26	Port Elizabeth	175
„ Teleg. mat. ..	105	Rotterdam. Teleg. wire ..	46
„ Teleph. cable ..	3,850	Sandakan	20
„ Teleph. mat. ..	54	Saseho. Teleg. cable	1,412
		Shanghai	342
		Singapore	90
		Stockholm	23
		Sydney	1,220
		Syra. Teleg. mat.	94
		Wellington	94
Total ..	£57,899	Total ..	£14,691

Foreign Goods Transhipped.

Malaga. Elec light cable	Value £32	Paris. Elec. mat. ..	Value £250
New York. Elec. goods	50	Perth. Elec. tram mat. ..	80
Perth. Elec. goods	113		
Total ..	£195	Total	£330

Bankruptcy Proceedings. — At a sitting of the London Bankruptcy Court held before Mr. Registrar Brougham on the 15th inst., Francis Beville de Foe Paynter, electrical, &c., engineer, late of 65-66, Chancery Lane, W.C., attended for public examination upon accounts showing total liabilities, £3,616 12s. 7d. (unsecured £2,009 19s.), and assets valued at £1,433 6s. 5d. In the course of his evidence the debtor stated that he had acted for a time as assistant engineer on the Midland Railway and inspecting engineer to the Otis Elevator Company, London. From May, 1898, to June, 1899, he carried on business at Chancery Lane as an electrical and mechanical engineer. He entered into an arrangement for the development of a patent burner for motor cars, but the scheme fell through owing to want of funds. During last year he had undertaken contracts for electric lighting, but the work obtained was insufficient to meet the expenses. His failure was caused by excess of expenditure over income, law costs, and exorbitant interest charged on borrowed money. The examination was concluded.

The first meeting of creditors was held at the London Bankruptcy Court on 15th inst. under the failure of Lewis Benjamin and Ernest Benjamin, trading together as Johnstone, Benjamin & Co., electric wire manufacturers, Ascham Street, Leverton Street, Kentish Town. Mr. E. S. Grey, Assistant Receiver, reported that it appeared from the debtors' statements that in 1890 the debtor Ernest Benjamin started business as Johnstone & Benjamin. He had no partner, but assumed the name of Johnstone, and upon being joined by Lewis Benjamin in 1892 the trading style was altered to Johnstone, Benjamin & Co. The business was carried on at successive addresses until last December, when it was converted into Johnstone, Benjamin & Co., Limited, with a capital of £15,000. The debtors received £500 in cash and £8,700 in shares and debentures of the company, and were appointed managing directors at a salary of £250 a year each. The business was now being carried on by the said company. A private meeting of the creditors was held recently, when an offer of a composition of 8s. in the £ was submitted and declined. The failure was attributed to undue pressure on the part of certain creditors. Accounts had been filed showing gross liabilities £8,116 3s. 11d. (unsecured £7,480 7s. 8d.), and assets valued at £5,912.

Mr. Osborne (Osborne & Osborne) attended on behalf of the debtors, whilst Mr Montagu and Mr Mossop represented creditors.

In reply to the Chairman, Mr. Osborne said he had no proposal to submit to the creditors at present, but hoped to be able to submit one in a few days.

Mr. Montagu expressed the opinion that the creditors would insist upon having the estate administered in bankruptcy. He moved a resolution to that effect.

Mr. Mossop seconded the resolution, which was carried without dissent.

Mr. Montagu hoped that a similar case would never occur again. The debtors had undoubtedly tried to defeat their creditors by placing the estate out of their reach. Acting on behalf of petitioning creditors (the Britannia Rubber Company, Limited), he issued a writ against the debtors on December 26th last, and on the following day they entered into an agreement to sell the business, goodwill, lease, plant, machinery, office furniture, trade marks, and implements to a company in return for shares which he doubted were worth the paper on which they were written, and debentures which were passed on to trustees of a marriage settlement. The debtors possessed no separate property, and had therefore not only denuded themselves of every atom they possessed in the world, but had placed the settlement trustees in front of the other creditors. He advocated the taking of steps to upset the transfer to the company, and with that end in view he proposed that Mr. B. T. Norton and Mr. F. S. Salaman should act as joint trustees to administer the estate in bankruptcy.

The meeting supported the proposition, and elected Messrs. Norton and Salaman to act with the assistance of a committee of inspection.

The public examination of the debtors is appointed for March 13th.

Appended is a list of the principal creditors:—

Unsecured.

Anns & Co., London	£170 3 8
Ancoats Vale Rubber Company, Manchester	188 9 1
Britannia Rubber Company, London	629 11 8
Bolton & Sons, Oakamoor	231 15 6
Bo'e Hall Mill Company, Tamworth	10 15 5
Back & Manson, London	124 6 8
Cassiser & Co., Charlottenburg	111 12 8
Christie, Grey, Limited, Glasgow	109 18 0
Charrington, Sells & Co., London	10 19 0
Craigpark Company, Glasgow	19 19 11
French & Co., Coventry	13 19 6
Franklin C., London	22 13 3
Fraser & Fraser, Limited, London	91 0 0
Fissmer, C., Hohenlembourg	102 10 1
Feising, C., jun., Blumenstrang	74 0 0
Goode & Son, London	11 6 0
Hankins, Bros. & Co., London	144 13 3
Hooper's, Limited, London	83 16 6
Healey, Geo., Cockcheaton	19 9 4
Haley & Son, Cleckheaton	13 12 6
Heddenheimer, Kupperwerke, London	161 1 11
India Rubber Company, Limited, London	71 4 0
John on & Phillips, Charlton	84 1 2
Kuhn, Nuremburg	64 15 5
Lynen & Co., Escleucier	127 2 0
Lindley & Co., London	125 5 0
Lazare Weiller et Cie. Angoulême	807 10 8
Land and Sea Kabel Company, Coln	2·9 19 9
London and Provincial Bank, London	173 14 2
Maygrove & Co., London	234 4 11
Macintosh & Co., London	29 16 3
Moseley & Co., London	45 0 0
Northern Electric Wire Company, Halifax	67 17 6
Phosphor Bronze Company, London	56 2 6
Pearsall & Co., London	121 16 9
Pickford & Co., London	14 10 0
Richardson, W., Manchester	97 18 6
Reed, C., London	31 0 0
Ramsden, Camm & Co., Brighouse	168 8 6
MacLellan & Co., Glasgow	149 12 2
Shropshire Iron Company, Hedley	295 0 9
Stratton, Gentry & Co., London	61 15 0
St. Helens Cable Company, Warrington	476 1 7
Smith & Co., F., Salford	94 1 0
Selig, Sonnenthal & Co., London	28 0 7
Thornton, Son & Co., Brighouse	141 15 10
Taylor, D. F., & Co., Birmingham	49 0 2
Watson & Co. Leek	285 5 5
Walker, R., & Co., Manchester	40 13 2
Wilkins Campbell & Co., London	13 9 4
Waters, J. & E., Limited, Manchester	89 9 10
Western Electric Company, North Woolwich	547 0 10
White & Sons, London	86 10 8
Brearley, R., Brighouse	10 0 0

Fully Secured.

Adams, A., Birmingham (security valued at £200) ..	150 0 0
Union Insurance Company, London (security valued at £35)	25 0 0
Liabilities on bills	400 16 3

The committee of inspection is as follows:—Messrs. Kingsbury, J. S. Watson, Montagu (of the Britannia Rubber Company), Patchett (of the Shropshire Iron Company), and Espir.

The *Glasgow Herald* has a notice to the effect that Francis Teague, electrical engineer, residing at Electric Works, Blackhall, Paisley, is to be examined in the Sheriff Court House, Paisley, on February 26th.

On Monday C. B. Harness, late managing director of the Medical Battery Company, applied at Wandsworth County Court for his discharge. It was stated by the assistant official receiver that the liabilities were £8,289, and nothing had been realised, the debtor having, it was alleged, contracted debts without having reasonable expectation of paying them. For the debtor it was stated that although the company had cost over £50,000, the whole of the stock, &c., was sold at the break-up price of £1,800. The proprietors of the Electrical Review were represented, and opposed the application, they being creditors in respect of costs of certain

successful actions against bankrupt and his company. The discharge was suspended for three years.

A trustee (Mr. R. M. Burgess) has been appointed in *re* T. A. Flather, electrical engineer, Leeds.

George S. Proctor, optician, &c., 14, Portland Street, Coatbridge, sole partner of the firm of George S. Proctor & Co., electricians, &c., Coatbridge, is to be examined in the Sheriff's Chambers, County Buildings, Airdrie, on February 26th.

Sequestration. — The estates of Hiley & Orchar, electrical engineers, Dundee, as a firm, and J. M. Hiley and W. Orchar as partners, were sequestrated on February 16th.

Catalogues and Lists.—The B.T.H. Company has issued its pamphlet, No. 87, in which an article on "Electric Locomotives for Mine Haulage" is reprinted from a contemporary. There are some excellent illustrations of small B.T.H. electric locomotives.

The Phœnix Foundry Company, Limited, of Derby, sends us several circulars relating to its pressed steel culverts for electric cables. Pressed steel culverts on the company's principle are claimed to be an improvement on other systems, both as regards strength and ductibility; they can be made in any length, and with bends and make-ups, and by their use the threading and tearing of cables is avoided. The Phœnix system is applicable to centre rail-guides, buckled plates for overhead wire poles, and all kinds of clips therefor; also to segmental chimneys and tanks for power stations. The circular shows a few standard sections of culverts which have been adopted by leading cable makers in this country.

"I.T.E." automatic magnetic circuit-breakers are pretty well known among electric traction men in this country. A calendar, which has just been issued by Messrs. R. W. Blackwell & Co., Limited, gives a large sectional view, in colours, of the breaker, showing its action in a very clear manner.

The General Electric Company (1900), Limited, are circulating an eight-page list of their new short type "Solar" enclosed arc lamps for insertion in Section B of their catalogue; also a list of their steel interior conduit system.

Messrs. Miller & Co., Limited, of London Road Foundry, Edinburgh, recently placed before us a catalogue of their various manufactures, including chilled iron wheels for tramways, railways, mines, &c., chilled iron points and crossings, brake shoes and like accessories, in fact, chilled iron castings for all purposes. Miller's wheels have been supplied to a large number of English and Continental tramways with satisfactory results, as the numerous testimonials which are given in this list show. The firm has for a long time experimented with the object of procuring a chilled wheel which, although exceedingly hard on the wearing surfaces, is capable of resisting the binding strain of curves, and they claim that their car wheels now being supplied will meet these conditions, and at the same time give a length of life which ensures an economy over steel-tyred wheels. Illustrations and sections of electric motor car wheels of several weights and diameters are shown, also wheels on axles, tramway points and crossings, &c.

The latest catalogue of wood-working machines and electrical appliances made by Messrs. W. B. Haigh & Co., Limited, of Oldham, contains details of their combined engines and dynamos for ship-lighting and small private plants, a specification of high-speed engines, particulars of their two-pole undertype generators, "O" type continuous-current dynamos, type "E" enclosed motors, motor-driven plain, band saw machines, enclosed motors in combination with planer and thicknessing machines. Steam boilers (Cornish, Lancashire, vertical engines and boilers) and a great variety of wood-working machinery are well illustrated and generally described in the remaining 160 or 170 pages. The catalogue is one worth filing for reference.

The Bristol Tramways Company's traffic manager, Mr. Charles Challenger, has written a handbook to Bristol for the guidance of visitors. There are, of course, many good sights to be seen, and the chief features of interest are brought to notice. The Bristol electric tramway service now runs in all directions, and it is, therefore, not surprising to find that the sights are mainly along the route of the tramway system.

The Lister Electric Light and Power Manufacturing Company, of Dursley, Glos., sends us one of its wall calendars for the year.

From the High Speed Engine Company, Limited, of Sclessin-Liège (English representative Mr. J. P. Phibbs, of Wool Exchange, E.C.), we have received a nicely illustrated catalogue, in which are stated the advantages of the Carels' high-speed engines, together with a description and sectional illustrations of the same. The various parts—cylinders, pistons, valves, governor, steam drying apparatus, and other details—are most clearly shown.

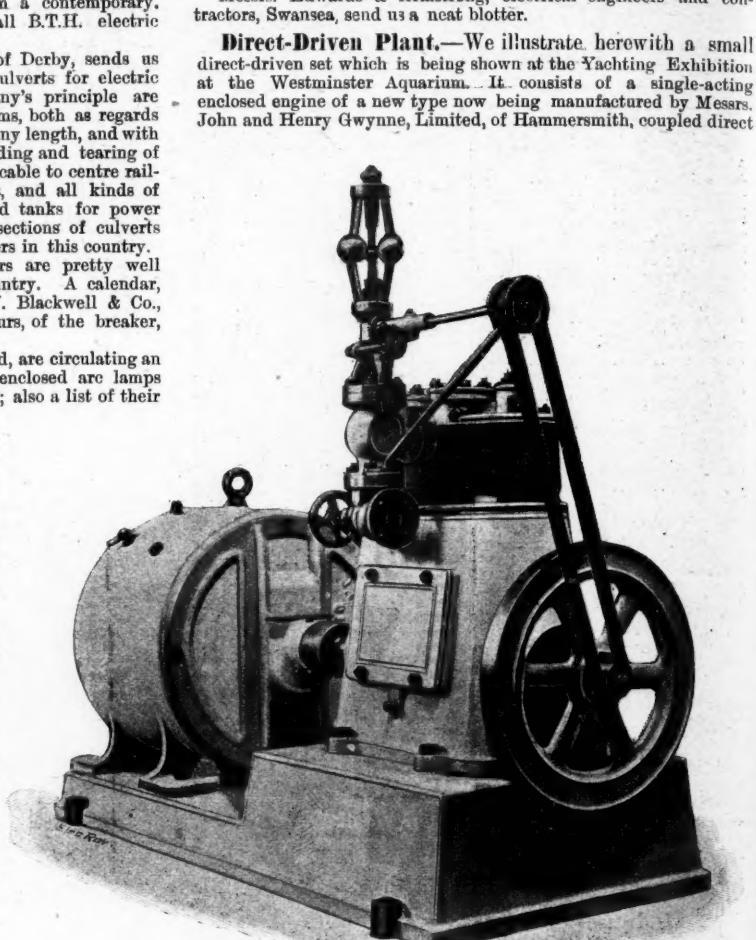
The American Blower Company, of Gracechurch Street, E.C., send us a pamphlet in which are given particulars and drawings of the A.B.C. fan system of mechanical draught for boilers.

Messrs. William Soutter & Sons, Limited, art metal workers, of Birmingham, have just brought out some excellent sheets of their electric light fittings. The designs shown of these "Stalactite" fittings are very artistic and pleasing, and the same terms of praise are equally applicable to the manner in which they are printed in colours. The fittings, which are priced on an advance sheet, comprise wall fittings, standards, electroliers, hall lanterns, &c. They are made from the best rolled sheet metal, and each arm or section is cut and fashioned in one piece, thus dispensing with unnecessary joints. The parts are then securely fixed to a main stem.

The Electrical Company, Limited, has brought out two new lists. No. 10 is devoted to lampholders for various purposes; No. 15 deals fully with the company's measuring instruments for direct and alternating currents, dead-beat instruments for D.C., dynamo metric wattmeters, phase meters, induction measuring instruments for A.C., electrostatic voltmeters for D. and A.C., instruments for testing insulation, switchboard transformers, Wheatstone bridges, cable testing vans, and a number of the company's other specialities. The lists are both fully illustrated.

Messrs. Edwards & Armstrong, electrical engineers and contractors, Swansea, send us a neat blotter.

Direct-Driven Plant.—We illustrate herewith a small direct-driven set which is being shown at the Yachting Exhibition at the Westminster Aquarium. It consists of a single-acting enclosed engine of a new type now being manufactured by Messrs. John and Henry Gwynne, Limited, of Hammersmith, coupled direct to an enclosed dynamo made by Messrs. J. P. Hall & Co., of Oldham. The output of the set is 40 amperes at 110 volts at 500 revolutions per minute when the engine is supplied with steam at 90 lbs. pressure per square inch. In order to prevent excessive heating the dynamo is ventilated in a manner patented by Messrs. Hall, in which air is drawn through a recess in the bearing of the driving end of the machine, passed through the case, and ejected through a recess in the bearing at the commutator end. At the commutator end of the machine, which is not shown in the illustration, two glass doors are provided the full depth of the machine, and these when open give easy access to the brushes and commutator. A plant of this type is specially suited for work in the open air or in dirty places, or in cases where the stray field from the magnets of an open machine would have a prejudicial effect on compasses or other magnetic instruments.



Direct Driven Plant.

Acetylene Lighting.—The *Financial Times* says that the unsatisfactory condition of the calcium carbide industry and acetylene gas lighting on the Continent recently led to the formation of a syndicate of German, Swiss, Austrian, Swedish, and Norwegian carbide works, which resolved to establish a single sales bureau through the intermediary of the Gold and Silver Scheide Anstalt, of Frankfort-on-the-Main. With a few exceptions, the members of the syndicate have since then been compelled to shut down their works in order to reduce the excessive stocks of carbide which have accumulated, and it is not known how long the cessation of manufacturing operations is likely to continue. One of the exceptions is the well-known Aluminium Company, of Neuhausen, which has on hand old orders from the Prussian State Railway authorities which will occupy the company for a further period of two years.

The total annual production of the syndicate works amounts to 50,000 tons, whereas the consumption is only about 12,500 tons yearly in those five countries. It will thus be some time before the accumulated stocks will be reduced, and any advance take place in the unremunerative prices which have prevailed for so many months. The Continental situation of the industry is rendered all the more critical by reason of the fact that considerable over-production exists also in France and Italy, where the output is likewise four times in excess of the consumption.

Annual Festival.—The second annual festival of the employés of the Glasgow Corporation Electricity Department was held in the City Hall on 13th inst.

Bailey v. George.—In the Nisi Prius Court at Gloucester Assizes, the case of S. G. Bailey & Co., Limited, manganese mine owners, &c., of Stroud and London, *v.* W. & J. George, Limited, of Birmingham, chemical and electrical apparatus manufacturers, was heard. The general nature of the dispute between the parties was as to whether there was on May 16th a contract for the supply of 100,000 carbons of one size, and 100,000 carbons of another size. In the result the judge found for the defendants on the main issue as to whether there was a contract, with costs on that issue; defendants to pay 4s. more into Court, and accept delivery of 2,000 carbons at 50s. per 1,000, costs on that issue to plaintiffs; no general costs of the action.

Books Received.—"Matriculation Directory, No. XXIX., January, 1901." Cambridge: University Correspondence College. 1s. net.

"Street's Newspaper Directory" for 1901. London: British, Foreign and Colonial Advertising Offices. 3s. 6d.

"Prime Noziori Fondamentali di Elettrochimica," by Alfonso Cossa. Milano: Ulrico Hoepli, 1901. Lire 1—50.

"Recenti Progressi Nelle Applicazioni dell' Elettricita," by Rinaldo Ferrini. Third edition, 1901. Milano: Ulrico Hoepli. Lire 7—50.

Charge of Cutting Telephone Wires.—Last week John Nolan, of Barking, was summoned at Stratford for maliciously cutting telephone wires belonging to the National Telephone Company on January 17th, and he was committed for trial. During the last 12 months no less than £90 worth of wire has been cut in the Barking district. At one time the telephone service between London and Tilbury was suspended in consequence.

Cults Nuisance.—The Second Division of the Court of Session, on 13th inst., heard counsel, and disposed of an appeal from the Aberdeen Sheriff Court in an action by Mrs. Frances Machray or Cameron, Heathville, Cults, against P. C. Middleton & Co., 258, Union Street, Aberdeen. The circumstances have already been noted in these columns. Their Lordships indicated that they were of opinion that the Sheriffs were right, and that there had been a nuisance. They continued the case in order that the defenders might consider whether they could abate the nuisance by any means.

Debate on Electric Lighting.—The Croydon Debating Society listened to an address on Wednesday, 13th inst., by Mr. Perren Maycock, M.I.E.E., the subject being "Is Electricity Dearer than Gas?" The advantages of the electric light and the equitability of the maximum demand system received full treatment at the hands of the lecturer.

Employers' Liability.—A machinist named Trimnell took action against the British Electric Works Company under the Employers' Liability Act, claiming damages for the loss of an eye, and the jury awarded him £150. It appears that he had already been paid something under the Workmen's Compensation Act.

For Sale.—The stock-in-trade of Bunce Bros. & Co., Limited, electrical fittings manufacturers, of Halifax, now in liquidation, is offered for sale. See an advertisement in this issue.

Under a deed of assignment *re* G. S. Stegmann, electrical engineer, Clapham Junction, the trustee is offering for sale a large quantity of electrical stock, machinery, &c., and full particulars will be found among our advertisements to-day.

Foreign Electrical Imports.—The value of the foreign electrical goods and apparatus imported into England during the past month is returned at £94,317 as compared with £147,205 in December last and £63,153 in January, 1900.

Fulham Electricity Works.—We regret that in our article last week, describing the above works, we omitted to mention that the internal wiring for the station lighting was carried out by Mr. T. L. Hellyar, of Fulham and Hammersmith, with Simplex tubing.

Macnaghten v. Traill and the Giant's Causeway Electric Railway.—This action, which was fought in the Belfast Courts, was brought by Sir Francis Macnaghten to restrain the defendants from interfering with the flow of the River Bush (of which he claims the several fishery rights) by reason of their user of the water-power for generating electricity. The defendants have a counterclaim against the plaintiff for interfering with their turbine wheels by flooding, caused by the erection of a weir, and they deny his title to the several fishery rights of the River Bush.

Mr. Herbert Wilson applied on behalf of the plaintiff for liberty to amend the pleadings by adding Dr. Anthony Traill as a defendant. The lease under which the Wark Mills were held was made to the defendant, Wm. A. Traill, the engineer to the company, and also to Dr. Anthony Traill. Opposite these mills there was a fall in the river called "The Leap," which extended for 80 yards. Since the electric trains started to work by electric power the old mills had been enlarged, and a greater quantity of water than heretofore was brought to these mills. The consequence was that nearly all the day long the water passing over "The Leap" was practically nothing. Artificial freshets and artificial stagnation were alternately created, thus interfering with the natural flow of the water. Counsel stated that Dr. Traill was chairman of the company, and was the moving spirit in the whole matter.

The Vice-Chancellor said he could see no ground for making Dr. Traill a party to the action.

Newspaper Directory.—"Street's" is as well known as any of the London newspaper directories. The 1901 issue has just appeared. There is no radical departure from the system of arrangement which its compiler has followed for some years past, but by reference to its several sections as indicated by the headings' contents it is easy to find the name, address, date of publication, and so on of any paper appearing in this country. ("Street's Newspaper Directory," Serle Street, W.C., 3s. 6d.)

Niagara Turbines.—The Niagara Falls Power Company has awarded a contract for six new 5,000-H.P. turbines to the I. P. Morris Company, of Philadelphia, Pa. These new turbines will be somewhat different from the present turbines, and will be built after designs prepared by Escher, Wyss & Co., of Zurich, Switzerland. It will be recalled that the turbines now in use were built to plans prepared by Piccard Pictet & Co., of Geneva, Switzerland. Dr. Coleman Sellers, chief engineer of the Niagara Falls Power Company, and William A. Brackenridge, resident engineer of the same company, visited Geneva, Switzerland, some months ago in regard to the new turbines and their design. Upon their return last spring the Niagara Falls Power Company invited competitive plans from Escher, Wyss & Co., of Zurich, Switzerland, and these plans have now been accepted. There are two wheels in the present turbine, but it is understood that the new turbines will have but a single wheel. Other features in which they will differ will be principally by the guides and buckets being enclosed in the wheel case, and having draft tubes which will allow the utilisation of the full head available. The contract for the new turbines provides that they shall be delivered about August next. They will be used to drive the six 5,000-H.P. generators, contract for which was awarded to the General Electric Company, Schenectady, in November last. The consulting hydraulic engineer of the Niagara Falls Power Company is Clemens Herschel. The new wheel pit has reached a depth approaching 120 feet. Work is being carried on night and day. While the full plans for the new power house have not yet been announced, and while its general design will be similar to the present station, it is known that there will be numerous new features in the interior arrangement.

Trade Announcements.—Notice comes to hand from Essen-Ruhr to the effect that the name of the firm "Chemische Thermo-Industrie, G. m. b. H," has been altered to "Allgemeine Thermit-Gesellschaft, m. b. H."

Mr. Arthur Koppel informs us that in consequence of the increase in his business, he has removed from Peninsular House, Monument Street, E.C., to more commodious offices at 27, Clements Lane, Lombard Street, E.C.

Visit to the Tower Bridge.—By the kindness of the chairman of the Bridge House Estates' Committee, about 50 members and friends of the Civil and Mechanical Engineers' Society spent a couple of hours recently in exploring the machinery and pumping station in connection with the Tower Bridge, and were fortunate in witnessing the operation of raising and lowering the bascules twice.

"Words and Things."—This is the title of an interesting book of about 100 pages, in which are noted some of the developments of the English language during the last century, and some of the new processes and discoveries whose introduction has necessitated new words. To review such a book as this is impossible, nor is it sent to us for that purpose, but we may remark that a glance through its pages gives one a liking for the "Century Dictionary" published by the *Times*.

ELECTRIC LIGHT AND POWER NOTES.

Alfreton.—The U.D.C. has appointed Messrs. Gibbings and Baker as consulting electrical engineers.

Arbroath.—Last week the T.C. decided to carry out the electric lighting of the town without placing the prov. order in the hands of an electrical engineering company. The installation is estimated to cost about £30,000.

Ashton.—The Corporation has engaged Mr. Hammond to report on the electricity works, with the result that he recommends further expenditure on plant.

Bury St. Edmunds.—The T.C. has resolved to apply to the L.G.B. for leave to borrow £12,000 for public lighting and extensions of the electricity works.

Carnarvon.—A public meeting has expressed approval of the opposition raised by the T.C. to Mr. Peterson's scheme, which is based on an alleged breach of faith.

Chatham.—The Corporations of Rochester and Chatham and the Gillingham (New Brompton) D.C. are now in negotiation with the Chatham, Rochester and District Electric Lighting Company, which has works both at Chatham and New Brompton, with a view to taking over the whole undertaking. There are very few towns so situated as Chatham and New Brompton, to say nothing of Rochester, with a population of over 100,000, inclusive of so many Government departments. For instance, there is the large Royal Dockyard, the Royal Marine Barracks, Royal Engineer Barracks, together with the School of Military Engineering and the Submarine Mining School, and the Foot Barracks at Chatham. The new Naval Barracks and the enormous Naval Hospital now being erected will also require a large number of lights. There ought also to be a big private demand.

Dewsbury.—The Corporation, who have electricity works of their own, have decided to oppose the Yorkshire Electric Power Bills.

Dublin.—The Master Electrical Contractors of Dublin have addressed a letter to the Electric Lighting Committee of the Corporation, asking them to take further advice before they proceed with the Pigeon House scheme. The bad site, and unsuitability of the proposed supply for motor work, are the principal objections urged.

East Cowes.—The D.C. has consented to the Isle of Wight Electric Light and Power Company's application for a prov. order for the supply of electricity in the district.

Eversham.—The T.C. has decided not to take up electricity supply.

Gravesend.—The T.C. has passed a resolution in favour of the electricity scheme drawn up by Mr. Trentham.

Greenock.—The first annual statement of accounts of the electricity department shows a deficit of £588. Bailie Mitchell holds that the actual deficiency should be stated at £1,377, and he moved that the accounts be remitted back and brought up a month hence. The Electricity Committee convener agreed to do so.

Hampton Wick.—The D.C. has appointed Mr. Lacey to report on the draft agreement with the Richmond Electricity Company.

Hartlepool.—The T.C. is going to purchase an additional steam dynamo to meet the increasing demand.

Hendon.—A meeting of owners and ratepayers will be held here on Thursday next, when Mr. R. Hammond will explain the electric lighting scheme now under the consideration of the District Council. It is understood that the Electrical Power Distribution Company is approaching the Council with a view of supplying energy in bulk.

Hereford.—The results of the last year's working of the electricity works show a profit of £335 towards repayment of capital.

Kinning Park.—The Commission has resolved to apply for a prov. order to supply electricity, and has appointed a Committee to oppose the Clyde Valley and Caledonian Power schemes.

Klondike.—We understand from the *Electrical World* that the electric light and power plant at Dawson, on the Klondike River, is the only electric power plant in the world furnishing power for a number of different placer mines over a placer mining district. This plant is the property of J. A. Williams, and is operated by the Dawson Light and Power Company, of which Capt. Donald B. Olson is manager. About 3,000 lights are connected in Dawson, while on the small placer mine claims scattered up the creeks along the river there are about 1,500 lights and 30 motors driving centrifugal pumps for working placer mines. The power house contains a 200-KW. three-phase General Electric generator giving 2,300 volts, at which pressure the distribution around the town and district is made. Wagner transformers are used, and Westinghouse motors. A 300-H.P. Ideal engine and a 300-H.P. water-tube boiler, made by the Standard Boiler Manufacturing Company, of Harvey, Ill., complete the equipment. It is thought that the plant is the most northerly electrical installation in the world.

Lewisham.—The Borough Council last week decided to consent to the application by the Lewisham and District Electric Supply Company, Limited, for a prov. order to supply electricity in the parish.

London.—County Council.—The generating station erected by the County Council at the Victoria Embankment (on ground adjoining the Charing Cross station of the District Railway), for the purposes of the electric light installation for the Embankment and Westminster Bridge, will be formerly opened to-morrow by Mr. W. H. Dickinson, the chairman of the Council.

Hampstead.—An artesian well has been sunk by the Borough Council at the electric lighting works, partly to save the cost of water obtained from the West Middlesex Company, amounting to about £500 a year, and partly to prevent any danger from a breakdown or stoppage of the water supply. At a cost of £600 the well has been sunk 500 feet, and a yield of 600 gallons of water per hour obtained. It has been decided to proceed for another 100 feet, at a cost of a further £160, in the hope that a yield of 4,000 gallons an hour can be obtained.

Holborn.—At the meeting of the Borough Council last week, the town clerk was instructed to submit to the Council a statement showing what monopoly or monopolies for the supply of electrical energy in the borough now exist, when the same expire, and what steps will be necessary to ensure that every monopoly for such supply should be ultimately vested in the borough.

Stepney.—Mr. W. C. P. Tapper, resident engineer, informs us that the Borough Council has modified the charges for electricity supply, which are now as follows:—1d. per unit + a monthly rental of 7d. per 8-C.P. lamp shown by the demand indicator, or 8d. per unit up to 30 hours' use of the maximum demand, and 1d. per unit afterwards. The demand indicators will not be read during the six summer months, the value for the March quarter being used.

Shoreditch.—After considerable discussion on Tuesday the Borough Council approved the action of the Lighting Committee in appointing the chairman (Mr. Winkler) and the engineer (Mr. C. Newton Russell) to attend the inquiry to be held by the Board of Trade in relation to the proposed amendment of the regulation concerning the alteration in the supply pressure from 110 volts to 200 volts. The representatives were authorised to support the amendment, having due regard to the position of consumers.

Lowestoft.—The electricity works, which were opened last week, consist of engine room 80 feet × 30 feet, boiler room 80 feet × 38 feet, battery room, &c., the first two of which are provided with a concrete foundation 4 feet thick, tied together with iron rails. The chimney is 120 feet high × 8 feet diameter, and was erected by the Horsfall Destructor Company. Two Babcock and Wilcox boilers are in place, and two erecting, with a Green economiser. The steam dynamos were supplied by Messrs. Musgrave & Sons, using their own engines and British Thomson-Houston dynamos; one is of 150-KW. output, the other 75 KW. An additional set of 250-KW is on order from the Lancashire Dynamo and Motor Company, with a Browett-Lindley engine. B.T.H. balancers and boosters are also provided, as well as a Chloride storage battery of 400 ampere-hours capacity. The main switchboard was put in by Messrs. Laurence, Scott & Co., Limited, the feeders and mains by Messrs. Callender; the 69 public arc lamps are of the Crompton-Pochin type, and were installed by Messrs. J. W. Brooke & Co., Limited, of Lowestoft, who also wired the station. Applications have been received for a supply equivalent to 5,000 8-C.P. lamps, and the prospects before the undertaking are bright.

Manchester.—The appointment of Mr. G. F. Metzger as chief electrical engineer, in succession to Mr. Wordingham, gave rise to a scene at the adjourned meeting of the Manchester City Council on Wednesday. Dr. Bishop, chairman of the Electricity Committee, moved the appointment at a salary of £800 a year. Sir John Harwood regretted they were losing the services of Mr. Wordingham, who was the cleverest man in the whole country. He believed they were going to carry out his plans, and he was deeply grieved that so civil, so able, and so obliging a servant was going away. Alderman Richards remarked on the hostility of the Electricity Committee to Mr. Wordingham. The resolution having been carried, Mr. Lambert gave notice that at the next meeting of the Council he would move that the resolution be rescinded. Dr. Bishop said that under such circumstances the Committee would not accept the responsibility, and as it was pointed out that Mr. Wordingham would not remain with the Corporation under any circumstances, the resolution was put a second time and carried.

Paris.—According to a letter of Mr. H. A. Mavor in the *Glasgow Herald*, there are now 1,680 arc lamps in use for lighting the streets of Paris.

Penge.—On Monday night the U.D.C. granted an application received from the Lewisham District Electric Supply Company, Limited, for the Council's consent to the company's application for a prov. order to supply electricity in the district. The draft agreement is practically the same as that accepted by the Lewisham Borough Council.

Portobello.—A temporary failure of the electricity supply took place last week, owing to the breakdown of a transformer.

Prestwich.—The *London Gazette* contains the usual notice of transference of the 1900 electric lighting order to the Manchester Corporation.

Ramsgate.—The T.C. is inviting quotations for a supply of electricity in bulk from the Isle of Thanet Electric Tramways and Lighting Company, Limited.

Rhyl.—The principal streets are to be lighted with 18 arc lamps.

Richmond (Surrey).—The E.L. Company has reduced the charges for lighting from 7d. to 6d. per unit, for power from 6d. to 4d., and for meters 25 per cent.

Rickmansworth.—The D.C. favours the application of the North Metropolitan Electric Supply Company for a prov. order for electric lighting in the district.

Russia.—A company has just been formed at Oerlikon, Switzerland, with a capital of £40,000, to be known as the Russische Schweizerische Oerlikon Gesellschaft, to carry on an electrical engineering business in Russia.

Southampton.—The T.C. has resolved to apply to the L.G.B. for sanction to borrow £4,000, the cost of the new engine and other works connected therewith; and to accept the offer of

Messrs. Ferranti & Co., to supply a 300-KW. engine and alternator at the price of £3,000. The electrical engineer stated that the Harbour Board cranes have been transferred to the tramway system, thus making another engine available for lighting. The maximum load for the year was recorded on Christmas Eve, on which day it reached 630 KW., exclusive of the trams, which averaged 200 KW.

Stroud.—Public meetings at Stroud have ratified the Council's action in opposing the Gas Company's Bill, in which electric lighting powers are sought.

Taunton.—At the quarterly meeting of the Town Council last week the E.L. Committee reported that the actual profit made on the year's working exceeded £2,000, and after paying interest and sinking fund there remained a balance to the credit of the Committee of £706, which, added to £94 brought forward from last year, increased the balance to £800. It was decided to apply £450 to a reserve fund, £300 to the relief of the rates, and to carry the remainder forward to next year's account. This is the second contribution of £300 made by the Committee towards the relief of the local rates, whereas when the Corporation first took over the works from a private company it was necessary for several years to draw upon the rates to pay the interest falling due upon the loans and sinking fund. It was further decided to reduce the charge for each public arc lamp by £1 10s. per annum, to charge all places of worship owning their own installation 5d. instead of 6d. per unit, and to charge consumers under the demand system 3d. per unit instead of 4d. after the first hour. In view of the increased demand for light and power, the Committee recommended that further plant be laid down at a cost of £17,780. This matter was to be considered at a later meeting of the Council.

Teddington.—The U.D.C. has received notices objecting to its application for a prov. order from the Middlesex County Council, the Thames Conservancy, the Richmond Electric Company, and others.

Tonbridge.—The U.D.C. is going to apply to the L.G.B. for leave to borrow £20,000 for electric lighting purposes.

Whitehaven.—Mr. P. J. Watts, assistant electrical engineer at Manchester, has been appointed electrical engineer to the Whitehaven Council.

Wolverhampton.—Lieut.-Col. A. C. Smith, R.E., was to hold an inquiry into the application of the T.C. for leave to borrow £58,942 for electric lighting on the 21st inst.

ELECTRIC TRACTION NOTES.

Berlin.—The Grand Tramway Company, of Berlin, which operates no less than 257 miles of track in the German capital and employs 7,145 men, carried 236,000,000 passengers last year, as against 188,000,000 in 1899. The *Financial Times* says that the methods of working are the overhead trolley system of electric traction (453 cars), the electric storage battery method (420 cars), and horse cars numbering 1,371. The storage battery cars will probably be discontinued at an early date, and the horse cars will also be abandoned when the trolley system has been introduced throughout the tramway network. Although the working expenses increased owing to higher wages and shorter working hours, and absorbed 59·65 per cent. of the receipts, the net profits for the year amounted to £289,893, as compared with £267,896 in 1899. After paying £89,440 to the Berlin Municipality and other local authorities, in accordance with existing agreements, the company is able to pay a dividend of 11 per cent. for 1900, as compared with 10½ per cent. in the previous year.

Bradford.—On Monday night a guard wire broke at the Tyrrel Street terminus of the electric tramways. The wire came in contact with the trolley conductor, and there was some vivid flashing, but after about an hour's labour, during which the Lidget Green route was stopped, the line was cleared without injury being sustained by anyone.

Huddersfield.—Upon one of the steep gradients at Huddersfield on Monday last an electric car ran off the line at the curve at the bottom of the slope, and stopped at the causeway edge.

Bulgaria.—The first electric tramway in Bulgaria has just been completed and put in operation at Sofia. The lines have an aggregate length of about 12 miles. The water-power of the Isker, nine miles from Sofia, is utilised in the generation of the necessary electrical energy.

Cardiff.—The Watch Committee is going to alter or exchange its fire escapes so that they run horizontally when the new electric tramway wires are erected.

Carlisle.—In considering the probability of accidents with overhead wires, the Council instructed its surveyor and electrical engineer to visit Blackpool to see Mr. Quin's automatic cut-out at work. This patent cut-out was described in the ELECTRICAL REVIEW not long ago.

City and South London Railway.—The Bill which has been deposited at Westminster puts the estimated cost of the Angel—Agricultural Hall foot subway or tunnel at £40,592, but in view of the comments made by several shareholders at the recent meeting of the company, we can rest assured that the board will not proceed with the works without having the best of reasons for believing that the direct or indirect return on the outlay will be such as to justify the expenditure. The Bill also includes £300,000 additional powers for the company's undertaking generally.

Gravesend.—Messrs. Albright & Sellon recently interviewed the Works Committee on behalf of the National Electric Traction Company with reference to the gauge of the new tramways.

Halesowen.—The Light Railway Commissioners held an inquiry on Tuesday in the District Council Offices, Halesowen, relative to an application by the Council for an order to authorise them to construct light railways within their district.

Huddersfield.—The electric cars are now running on the Lindley, Edgerton and Outlane sections, they having been passed by the Board of Trade.

Liverpool.—At a meeting of the Liverpool Health Committee on Thursday of last week a recommendation by the city engineer, Mr. Brodie, that an application from the Post Office authorities for permission to construct overhead telegraph wires across Scotland Road at a point specified was considered by the Committee. The engineer stated that the poles carrying the wires would be about 150 yards apart. The deputy town clerk, Mr. Pierce, informed the Committee that if they refused to allow the construction of the wires overhead, the postal authorities could apply to a county court judge or a magistrate and obtain sanction on terms which might be laid down by such judge or magistrate. The Chairman asked if they could make them put the wires underground. The deputy town clerk replied that they could not. The city surveyor, Mr. Shelmerdine, objected to wires being put overhead at all. After some discussion it was decided to postpone the matter in order to see what powers the Corporation had with regard to the construction of overhead telegraph wires.

In the Liverpool County Court last week, Judge Collier had before him the application of a labourer named John Henry Lowther, for compensation for the loss of the sight of his left eye whilst in the employment of the Bootle Corporation. The applicant had been engaged dressing setts in connection with the reconstruction of the tramways in Rimrose Road, Bootle, on March 14th, 1900, when a chipping from a sett flew upward, striking him and destroying the sight of his left eye. In giving his decision, his Honour ruled that though applicant's connection with the tramway was remote, the employment came within the words "on or in, or about" the tramway. Then came the question, was the tramway an engineering work within the meaning of the Act? As far as it applied to the case, "engineering work" meant "any work of construction, alteration or repair, of a railway, harbour, dock, canal or sewer." The word "railroad" was also used in the definition. His Honour thought it might be assumed that a "railroad" was something different from a "railway," but the word "railroad" was never applied to tramlines. Tramlines or tramways were well known in 1897, and if the expression "engineering work" was intended to apply to them, he could not think the Legislature would have omitted to name them. He, therefore, found that the applicant's employment was not one to which the Act applied, and awarded accordingly.

On Monday afternoon a length of trolley wire on the Scotland Road lines, Liverpool, parted, the ends falling to earth. Inspector Conroy, of the electric car service, used his rubber gloves, and dealt with the wire until the arrival of the repair wagon. A stoppage of about half an hour was entailed.

Following the recent disaster by the fall of telephone wires, Mr. A. B. Holmes, the city electrical engineer, has recommended to the Watch Committee, who are responsible for public safety in the streets of the city, that in order to provide for assistance in case of breakages of wire, a supply of rubber gloves should be provided at the different police stations, where they can be readily got in case of emergency. The engineer has also intimated that a hooked stick or a folded newspaper may be used in the event of rubber gloves not being available. An umbrella, he states, must not be used on any account, owing to its metal ribs. The Watch Committee have decided that the foregoing and other recommendations of the electrical engineer shall be embodied in a general order to the police of the city.

Liverpool - Manchester Express.—On Monday the Garston U.D.C. (Lancashire) decided to oppose the Liverpool and Manchester Electric Express Railway Company's Bill, which will come before Parliament, the costs of the opposition to be defrayed out of the rates. Meantime, with a view to saving the cost of opposing, the Select Purposes Committee will consider if it is feasible to come to some arrangement with the company on receiving a report from the surveyor.

Manchester.—At a meeting of the Tramways Committee of the Corporation last week a letter was read from Prof. Kennedy, in which an intimation was given that the Bloom Street station ought not to be depended upon for a supply of electrical energy next winter on any tramway route other than the three decided upon, namely, Bury New Road, Cheetham Hill, and Rochdale Road. This means that no electric tramcars can be run on any other route for about 18 months, and probably not until the Stuart Street station is completed. It is expected that the wages bill for tramway employés will, roughly speaking, amount to about £16,000 per annum more than that paid by the Manchester Carriage and Tramways Company.

Newcastle.—Of the 21 miles of track contracted for, 11 miles have now been laid.

The Walker U.D.C. has decided to accept the offer of Newcastle regarding the running of electric cars to Walker. The tender for poles, from an English firm, has been accepted

Nottingham.—Speaking at a ratepayers' meeting on Monday, Councillor Mellor said that the Corporation were committed to gigantic expenditure in connection with the schemes they had on hand. The electric tramway system was only yet in its infancy. They were now at work on the Basford section, and when that was finished they would begin with the Trent Bridge line. Then there would be the St. Ann's Well Road district to attend to, and possibly there would be ramifications to Sneinton, and they had also to deal with Woodborough Road, Wilford Road, and even London Road. An immense amount of money would be required. Only the other day the Electricity Committee passed contracts for engines and plant for the new station amounting to £70,000, and that was a mere trifle. The expenditure on the tramways and the electricity department would amount to £700,000 or £800,000. It was essential, therefore, that they should give contracts only to those who were able to carry them out satisfactorily.

Scarborough.—The engineers to the Scarborough Electric Tramways Company have prepared, for the information of Parliament, detailed estimates of the cost of constructing the system as set out in the Bill for the present session. These estimates put the total cost at £79,545, of which £70,011 represents the cost of the proposed tramways, and £9,534 the cost of the new street, street widening, generating station, and car sheds.

Surrey.—At the meeting of the County Council on Tuesday, it was decided to spend a sum not exceeding £500 in opposing the Tramway Bill of the London United Tramways, Limited.

Teddington.—Details of the scheme of the London United Tramways, Limited, were discussed at the meeting of the U.D.C. last week, when it was decided to lodge a formal objection against the company's Bill. It was also decided not to consent to a clause allowing the Middlesex County Council to become the purchasing authority.

Tynemouth.—The Board of Trade inspection of the new electric tram service between North Shields and Whitley of the Tynemouth and District Electric Traction Company, Limited, took place on Wednesday last week. The date of the opening of the system to the public has not been fixed.

The Underground and Electric Traction.—Addressing the shareholders of the Metropolitan District Railway at the half-yearly meeting of the company on Thursday last, Mr. J. S. Forbes said that the only hope of the railway was electric traction, but there were a great many things to consider. There were a great many electrical doctors in the world who had many ideas, but they were being advised by a very eminent adviser, Sir W. H Preece. What they had first to consider, was what was to be the system. They had no less than nine proposals before them, and had yet to consider which to have, although he confessed to a preference for one system, because it was insisted upon by their technical advisers as the best. But most of the outside doctors said, "We do not care about technical advisers; we know better." As a matter of fact, everyone of the nine people knew better, but they were bound in honour to the Metropolitan Railway, and in justice to themselves, to a system which would be applicable to both companies. They must remember that the Inner Circle was a vital part of their system, and that the traffic must be carried by a system applicable to both railways. They could not have one system on the Metropolitan Railway and another system on their own railway. In the meantime they were in the position of a man troubled with many advisers, and they had to make up their minds as to which was the best system. The one they leaned towards was objected to as being too novel; but like all new things, their experts told them it was admirable and a great advance on any other system, and that the Americans were not in it. The Americans said they were, and that was the conflict going on. The directors would have to determine, but they would not determine without a great deal of consideration, nor did he know that they would determine in advance without consulting some of the largest shareholders of the company.

Underground Railway Bills.—The L.C. Council has resolved, on the suggestion of the Parliamentary Committee, to seal and present petitions, if necessary, against the following proposals, in some cases on questions of principle, and in others to obtain the insertion of clauses:—*Deep Level Underground Railway Bills.*—Brompton and Piccadilly Circus (Extensions); Central London; Charing Cross, Euston and Hampstead (No. 1); Charing Cross, Euston and Hampstead (No. 2); Charing Cross, Hammersmith and District Electric; City and Brixton; City and North-East Suburban Electric; City and South London; Islington and Euston; King's Road; North-East London; Piccadilly and City; and the West and South London Junction.—*Miscellaneous Bills*—Bexley Tramways; and the London United Tramways.

Urmston.—At the last meeting of the D.C. a letter was read from the promoters of a system of light railways from Altrincham to Sale, Ashon-on-Mersey, Urmston, and Flixton to Barton Bridge. Power will be sought to connect the proposed tramways with those running through Trafford Park and with the Manchester system. The members supported the proposal, and the letter was referred to the General Purposes Committee.

TELEGRAPH AND TELEPHONE NOTES.

Brighton Telephones.—At a meeting of the Regency Ward Ratepayers' Association on Tuesday last week, Mr. F. J. Madgen (the local manager of the National Telephone Company) gave an address on "Municipal Telephones."

Cable Communication.—Two meetings of the Cable Communications Committee have been held this week. The evidence of Sir Edward Sassoon, M.P., was taken.

East African Telegraphs.—The Budget Committee of the German Reichstag has sanctioned the expenditure of 200,000 marks for the construction of a telegraph line between Dar-es-Salaam and Mpwapwa, in German East Africa.

The Telegraph Wire Export Trade.—The new year has opened unusually briskly as regards the exportation of telegraph wire and apparatus from this country, returns just issued showing that the value of such exports during January last amounted to no less than £596,122, as compared with only £39,166 in the previous month, and £54,063 in January, 1900.

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
African—St. Louis (Senegal)-Bathurst	Aug. 25, 1900 ..	..
South American—Pará-Maranham ..	March 1, 1900 ..	..
Cayenne-Pinheiro	Nov. 26, 1900 ..	..
Latakia-Cyprus	June 20, 1899 ..	..
Marseilles-Barcelona	Jan. 7, 1901 ..	..
Fao-Bushire	Feb. 6, 1901 ..	Feb. 20, 1901
Havre-Waterville	Feb. 13, 1901 ..	Feb. 20, 1901
Landlines:—		
South American—Communication with Carthagena and Baranquilla	Dec. 8, 1900 ..	..
Chinese—Tientsin-Pekin	June 11, 1900 ..	..
Pekin-Kalgan	June 14, 1900 ..	..
Kalgan-Maimatchin	June 30, 1900 ..	..
Tientsin, *via* Shanghai	June 16, 1900 ..	..
Tientsin and Taku *via* Helampo ..	June 18, 1900 ..	..
Shanghai-Amoy	Jan. 18, 1901 ..	..
All lines connecting Cochin China with Thuanan	Oct. 23, 1900 ..	..
Communication "*via* Hanekine" interrupted on Persian territory	Feb. 26, 1900 ..	..
Lines beyond Vallona, Monastir, and Elbassan	Feb. 10, 1901 ..	Feb. 18, 1901
Saigon-Bangkok	Feb. 16, 1901 ..	Feb. 18, 1901

Wireless Telephony.—We read in the *Westminster Gazette* that Lieutenant Tadie, now on naval service at Cherbourg, is experimenting with the wireless telephone in view of giving submarine torpedo boats a means of communicating with land or with other vessels; and M. de Lanessan has also placed Captain Moritz, of the French Navy, on half-pay to enable him to study wireless telegraphy and telephony in relation to military and naval movements.

Wireless Telegraphy.—The Marconi International Marine Communication Company are establishing a wireless telegraphy station at Withernsea, on the Yorkshire coast. By establishing a station there, vessels from the Baltic and North Continental port can be communicated with while making for the Humber.

CONTRACTS OPEN AND CLOSED.

OPEN.

Aberdeen.—March 15th. The E.L. Committee wants tenders for fuel economiser and Babcock & Wilcox boilers. See "Official Notices" February 15th.

Amsterdam (Holland).—April 1st. The Communal Council will on this date consider tenders for the supply and erection of all the motors necessary, and the installation of the electric lighting of the power station, switchboards, &c. Conditions from the Municipal Printing Office, 10 florins (8s. 4d.). Information from the manager of the office of Electricity, Achterburgwal, 213, Amsterdam.

Accrington.—February 28th. The Corporation wants tenders for two steam dynamos (185-kw.), condensing plant, balancer, battery, piping, arc lamps and pillars. See "Official Notices" February 8th.

Batley.—The Town Clerk has instructions to advertise for tenders for engines and dynamos for the electricity works.

Beckenham.—February 25th. The U.D.C. wants tenders for boilers, steam alternator, and combined engine, dynamo and motor set, pipework, batteries and switchboard for electricity works extensions. See "Official Notices" January 25th.

Bermondsey.—February 25th. The Borough Council wants tenders for switchboard and instruments, and battery. See "Official Notices" February 8th.

Bournemouth.—March 2nd. The T.C. invites tenders for 42 electric cars. See "Official Notices" January 11th.

Bournemouth.—March 4th. The T.C. wants tenders for three steam dynamos, and two steam-driven surface condensers. See "Official Notices" January 18th.

Bray.—March 14th. The U.D.C. is prepared to receive tenders for Lancashire boiler and accessories, one 150-kw. high speed steam alternator, and one 25-kw. rope-driven alternator and accessories. See "Official Notices" February 15th.

Brighton.—February 25th. The Council wants tenders for continuous current arc lamps, &c., for street lighting. See "Official Notices" February 8th.

Cardiff.—March 18th. The Corporation wants tenders for steam, exhaust and other pipes, engine house flooring, switchboard gallery, &c., for electric tramways department. See "Official Notices" February 15th.

Chard.—The Corporation has decided to invite schemes and suggestions with a view to the public lighting of the town by electricity.

Clyde.—March 11th. The Trustees of the Clyde Navigation invite tenders for a 3-ton electric wharf crane for Prince's Dock. See "Official Notices" February 8th.

Dundee.—February 25th. The Gas Commissioners want tenders for underground electrical conduits and necessary jointing apparatus. See "Official Notices" February 15th.

Eastbourne.—March 4th. The Corporation wants tenders for transformers, sub-stations and equipments; mains, conduits, &c., arc lamps and posts. See "Official Notices" February 15th.

Farnworth.—March 1st. The Council wants tenders for tramway bonds. See "Official Notices" to-day.

Glasgow.—February 22nd. The Corporation wants tenders for the supply of 100 car equipments and spare parts for same. See "Official Notices" February 1st.

Halifax.—February 26th. The Electricity Committee wants tenders for a set of accumulators. See "Official Notices" February 15th.

Holland.—March 25th. Tenders are being invited until March 25th next by the municipal authorities of Amsterdam, for the equipment of a central electric lighting station in the city.

Huddersfield.—March 5th. The Corporation wants tenders for motor carts for conveying coal from local collieries to the electricity works. See "Official Notices" to-day.

Launceston (Tasmania).—April 22nd. The Corporation wants tenders for the supply of 500 electric meters. See "Official Notices" January 11th.

Luton.—March 4th. The T.C. wants tenders for electrically lighting the Council Chamber, Town Hall, Free Library, Corn Exchange, and Baths. See "Official Notices" January 18th.

Manchester.—March 4th. The Tramways Committee wants tenders for the electrical equipment of 87 cars. See "Official Notices" to-day.

New South Wales.—March 4th. The *New South Wales Government Gazette* states that tenders will be received at the Railway Commissioners' Office, Bridge Street, Sydney, until Monday, March 4th, 1901, from persons willing to contract for the supply, delivery, and laying of about 29 miles of 6,600-volt three-core lead-sheathed cable, and of about two miles of other cables, together with the necessary troughing, filling-in compound armouring, &c.

Portsmouth.—The Council's telephone expert is drawing up specifications, and tenders are to be invited, for the municipal telephone exchange system.

Roumania.—April 3rd. Tenders are again being invited until April 3rd by the municipal authorities of Ploesti, for the construction of an electric tramway in the town and the working of the same during a period of 30 years.

Southampton.—The Corporation wants tenders for insulated electric cables, frames and covers. See "Official Notices" to-day.

Spain.—February 21st. The Secretary for Foreign Affairs has received a dispatch from H.M. Ambassador at Madrid, stating that tenders are invited by the Spanish Government, not later than February 21st next, for the establishment of a telephone system in the City of Huelva; particulars at the Commercial Department, Foreign Office.

Stockport.—March 6th. The Gas and Electricity Committee wants tenders for condensing plant. See "Official Notices" February 15th.

Taunton.—February 25th. The Corporation wants tenders for two 100-kw. tramway generators, one engine, switchboard and connections. See "Official Notices" February 8th

The Hague (Holland).—March 25th. The Communal Council administration wants tenders for the supply and erection of engines and electric plant for the electric lighting of the town.

Wallasey.—March 4th. The U.D.C. wants tenders for the erection of car sheds, workshops, &c., also for extension of the electricity works (buildings and plant, including boiler, condensing plant, cooling tower, crane, engines and dynamos, cables, economisers and transformers). See two "Official Notices" January 25th.

Wallasey.—March 4th. The U.D.C. wants tenders for the overhead equipment of about 10 miles of tramways, the supply and erection of section boxes, and the bonding of rails. See "Official Notices" February 15th.

Worthing.—February 25th. The Corporation invites offers from electrical wiring contractors willing to undertake "free" wiring for consumers' premises. See "Official Notices" February 15th.

CLOSED.

Ballinasloe.—The *Contract Journal* states that the contract for the electric light plant for the new hospital block at the District Asylum has been given to the Ampere Electrical Company, Dublin, at £1,205.

Cheltenham.—The John Stephenson Car Company, of Elizabeth, N.J., has secured an order for eight double-deck trolley cars, which are intended for utilisation by the Cheltenham (England) Tramways Company.—*Electrical World.*

France.—Tenders were opened on the 7th inst. by the French Ministry of Posts and Telegraphs, in Paris, for the supply of a large quantity of galvanised iron wire. La Société Metallurgique de Gorcy, of Gorcy (Meurthe et Moselle), succeeded in carrying off the whole of the lots as follows:—15 tons 1 mm. diameter at 380 francs per ton, 180 tons 3 mm. diameter at 260 francs per ton, and 500 tons 4 mm. diameter at 250 francs per ton.

London.—The Shoreditch Borough Council on Tuesday accepted the tender of Messrs. J. Johnson & Sons, of Leicester, amounting to £16,633, for the erection of the new generating station in Whiston Street, Haggerston.

Poplar and Stepney.—For the electric light installation for the Poplar and Stepney Sick Asylum the tenders submitted varied from £1,750 to £4,075. The contract went to Messrs. Peacock & Co., at £2,039.

Sheffield.—The City Council has given a contract to the B.T.H. Co., for a 1000-kw. generator (£3,512), for the Cole, Marchent and Morley engine for Kelham Power Station.

Southampton.—Messrs. Ferranti have secured the contract for the supply of a 300-kw. engine and alternator at £3,000. A contract for coal at 16s. 9d. per ton has been placed with Messrs. Wood & Co.

The T.C. has accepted the tender of Messrs. R. W. Blackwell and Co., Limited (£2,079), for overhead electrical equipment for the tramways (St. Mary's Street Section). The tender of G. Milnes & Co., Limited, for 12 double-deck motor car bodies and trucks at £326 each has been accepted, also that of the British Westinghouse Company for motors and electrical equipments at £254 per car.

FORTHCOMING EVENTS.

Friday, February 22nd.—At 5 p.m. Physical Society. "How Air subjected to X-rays loses its discharging property, and how it discharges Electricity." By Prof. Emilio Villari.

At 8 p.m. Electro-Harmonic Society's Concert. Ladies' night.

At 9 p.m. Royal Institution. Sir W. Roberts-Austen, K.C.B., &c., on "Metals as Fuel."

Saturday, February 23rd.—At 2.30 p.m. Institution of Junior Engineers. Visit to the Willesden Station of the Metropolitan Electric Supply Company.

Institution of Electrical Engineers. (Students' Section). Visit to the Bankside Works of the City of London Electric Lighting Company.

At 3 p.m. Royal Institution. The Right Hon. Lord Rayleigh, M.A., D.C.L., LL.D., Sc.D., F.R.S., M.R.I. "Sound and Vibrations" (Lecture I.).

At 3.30 p.m. Civil and Mechanical Engineers' Society. Visit to Croydon Electricity Works.

Wednesday, February 27th.—At 8 p.m. Institution of Electrical Engineers (Birmingham Local Section). Inaugural Meeting in the University Buildings, Edmund Street, when Dr. O. Lodge, Chairman of the Section, will deliver an Inaugural Address, and the President of the Institution, Prof. J. Perry, will be present.

At 2.30 p.m. Institution of Civil Engineers. Students' Visit to the Electrical Works of the London United Tramways, Limited, Chiswick.

Thursday, February 28th.—At 8 p.m. Institution of Electrical Engineers. Ordinary Meeting to be held at the Institution of Civil Engineers. If the discussion on Mr. Madgen's paper is concluded, Mr. M. O'Gorman will read a paper on "Cables."

Friday, March 1st.—At 8 p.m. Institution of Junior Engineers. Meeting at Westminster Palace Hotel. Paper on "Carburetted Water Gas," by S. Cutler.

Saturday, March 2nd.—Institution of Electrical Engineers (Students' Section). Visit to the generation station of the London United Tramways Company at Chiswick.

Monday, March 4th.—At 7.30 p.m. The Cold Storage and Ice Association, Fishmongers' Hall. Mr. P. F. Kensett will read a paper on "Practical Insulation."

Tuesday, March 5th.—Institution of Electrical Engineers. (Students' Section). Mr. P. Lanbach will read a paper on "Arc Lamps."

Thursday, March 7th.—At 8 p.m. Civil and Mechanical Engineers' Society. Meeting at Hotel Victoria, Charing Cross, when a paper on "Authoritative Rules for Unit-Stresses in Railway Girders" will be read by J. R. Bell.

Saturday, March 9th.—At 3 p.m. Civil and Mechanical Engineers' Society. Visit to Kensington and Notting Hill Electric Light Works.

Saturday, March 16th. — At 7 p.m. Institution of Junior Engineers' Annual Dinner at the Westminster Palace Hotel.

NOTES.

Errata.—In the leaderette on page 306, line 9, read "transmitted through" for "generated in," and in the sixth line from end after the word generated, add "and received." In the article on "Dielectric Hysteresis," page 344, line 49, for "load" read "loss," and 11 lines further on for "No. 3 to 4," read "1,103 to 4."

The Passing of our Steel Trade.—Just as we are going to press we notice an announcement which appeared on Wednesday in the *New York Herald* to the effect that the New Steel Trust is to absorb Mr. Rockefeller's iron ore interest, known as the Lake Superior Consolidated Iron Mines, thus controlling one of the most valuable iron ore deposits in the country. The Duke of Devonshire alluded on Wednesday at a meeting of the Furness Railway shareholders to the serious depression in our iron and steel trades, which he attributed to the keen American competition, and he expressed the opinion that this competition, especially in regard to steel rails, would become even more acute, and a further depression in the home industry was inevitable. The above items seem to give additional point to what we had already stated in our leading columns.

X Rays at Ladysmith.—At a meeting of the Röntgen Society, held on 7th inst., at 20, Hanover Square, a paper by Lieutenant F. Bruce, R.A.M.C., on "Experiences of X Ray Work during the Siege of Ladysmith," was read by the hon. secretary, in the absence of the author. We read in the *Times* report that Lieutenant Bruce pointed out that Ladysmith afforded the first instance in which such work had been carried out under shell fire. There was little trouble about the apparatus itself, but the supply of electricity was not so easy a matter, since the town was not installed with the electric light. He had no faith in the system of driving a dynamo by a man on a bicycle, for the process of charging six cells in that way was like climbing a very steep hill; still he took a dynamo with him. In addition to the storage cells which formed part of his equipment, he applied for some of the large cells, which he noticed were used for lighting the train by which he travelled. In Ladysmith two small rooms in the Town Hall were set aside for X ray work, and one of them was fitted up as a photographic dark room. The battle of Elandslaagte furnished the first cases; in these, while there was much bone splitting, there were few cases of embedded bullets, though in those that did occur they were successfully localised. When the Boers cut off the main water supply, there was a scarcity of water for washing the plates, and what there was available was exceedingly dirty. The fighting on October 30th yielded many cases, and as the supply of electricity was giving out, it became necessary to do something to get the batteries recharged. This was managed at a flour mill near the Town Hall, the dynamo brought by Lieutenant Bruce being attached to the mill shafting. The arrangement worked well, the current obtained supplying electric light to the operating room by night, besides charging the cells. On November 5th they had to move across the Klip, owing to attention from Boer shells. The wagon stuck in the middle of the river, and when they did arrive at Intombi, their destination, there were no tents available for them, and their apparatus had to lie on the bare ground for two days until the tent came. Later, they were ordered back to Ladysmith, in case the relieving columns arrived. They were not allowed to return to their old quarters, as they wished, and therefore had to build a shell-proof house for themselves on a site on a hill; the walls of this were about 3 feet high, when a storm washed everything away. Then the Congregational chapel was chosen as their station, but after a week there they were ordered to return to Intombi; the batteries still continued to be charged in Ladysmith at the mill. The battle of January 6th showed some interesting cases, apparently due to the use of explosive bullets by the Boers. The X rays were employed in all in some 200 cases, nearly half being photographed, and the apparatus proved itself of great advantage. As to improvements suggested by his experience, Lieut. Bruce thought a properly constructed operating table was required, in which, if desirable, the photograph could be taken from below. But the generation of electricity was the chief point, and he was of opinion that for field use an outfit could not be considered as complete unless it had its own machinery for the production of electricity. He suggested that an oil motor, like those used on motor tricycles, might be provided to drive the dynamo. At the end of the paper some of Lieut. Bruce's actual photographs were exhibited, and proved to be remarkably good considering the difficulty of the conditions under which they were taken and developed.

Naval Boilers.—In the House of Commons on Monday Mr. C. Wilson asked the Secretary to the Admiralty whether the Admiralty had recently given orders that the *Encounter*, the *Cornwall*, the *Queen*, and the *Prince of Wales* should be fitted with the Belleville water-tube boilers; if so, why this had been done pending the report of the committee of experts now inquiring into the matter, and when was it expected that such report would be made? Mr. Arnold-Forster, in reply, said that the Admiralty policy in the matter of boilers was described in the memorandum on water-tube boilers which was presented to Parliament, and in accordance with that policy the four ships named in the question were ordered to be fitted with the Belleville boiler, but in the event of the report of the Committee indicating the necessity of a change in the type of boiler, this decision will be reviewed in all cases where it may be found practicable. The *Challenger*, the sister ship to the *Encounter*, is being fitted with Babcock & Wilcox boilers for comparison with the Belleville boilers in the latter ship. Babcock and Wilcox boilers are also being fitted in the *Espiegle* and *Odin*, and Niclausse boilers in the *Suffolk*, sister ship to the *Cornwall*, and in the *Merlin*, for comparison with other ships of the same classes fitted with the Belleville boiler. The committee have been requested to make an interim report on any of the points referred to them, as soon as they have collected sufficient evidence or experimental proof to enable them to form a reliable opinion.

It is announced by Mr. Arnold-Forster that the interim report may be presented to the Admiralty in the course of the next few days.

The Danger of Falling Wires.—The *Review of the River Plate* relates that last month a telephone wire belonging to the Pacific Railway Company broke and fell across six wires of the Union Telefónica and the trolley wire of the Belgrano Tramway Company. The six wires were immediately fused and one of them fell on the two horses of a passing Victoria, killing them immediately.

The Liverpool Accident.—The adjourned inquest on the two men who were killed in the Liverpool overhead wire accident was held on Wednesday and Thursday. The jury found that the men died from electric shock, and that the accident would not have occurred if the spans of telephone wires had not been so lengthy.

(*Continued on page* 329.)

A NOVEL ELECTRIC RAILWAY.

In the presence of the Kaiser and Kaiserin, the Imperial Secretary of State, the Prussian Ministers and leading men in commerce and industry, &c., the Barmen-Elberfeld-Vohwinkel Suspension Railway was opened the other day at Elberfeld, and we give some views of this novel line, which has no parallel in this country.

The railway is the invention of Herr Eugen Langer, the well-known Cologne manufacturer, who died in 1895. The cars on this line, as may be seen on the view of them over the River Wupper, hang free—after the manner of the wire-rope railways — from a rigid overhead rail, which is supported by an iron framework, constructed in accordance with the particular features of this railway. The first experiments were made by the inventor in 1893, and immediately after their successful conclusion, the plan for a suspension line between Barmen and Elberfeld, two great neighbouring manufacturing centres, was drawn up, on the initiative of Baron von der Heydt. After further experiments, its construction was decided upon by the town authorities in 1895, and the work begun in 1898.

Construction over Roadway.

The railway is a little over eight miles in length, and begins in reality at the Barmen Ritterhausen Railway Station; it runs through the towns of Barmen and Elberfeld, following the course of the River Wupper, as was inevitable, owing to the many houses and the narrowness of the valley.

Just beyond Elberfeld the line leaves the river and follows the road through Sonnborn to Vohwinkel, where it terminates near the general railway station. At present the Elberfeld section is ready and in working order, whilst the Elberfeld—Vohwinkel section will be completed during the winter, and the Barmen section later on. The railway follows the fall of the Wupper and ascends in accordance with the rather steep gradient of the road between Elberfeld and Vohwinkel. There will be 20 stopping places in all, four on the Barmen section, eleven on the Elberfeld, and two on the Vohwinkel section, the distance between them varying from 325 to 1,000 yards.

An Aerial Railway Station.

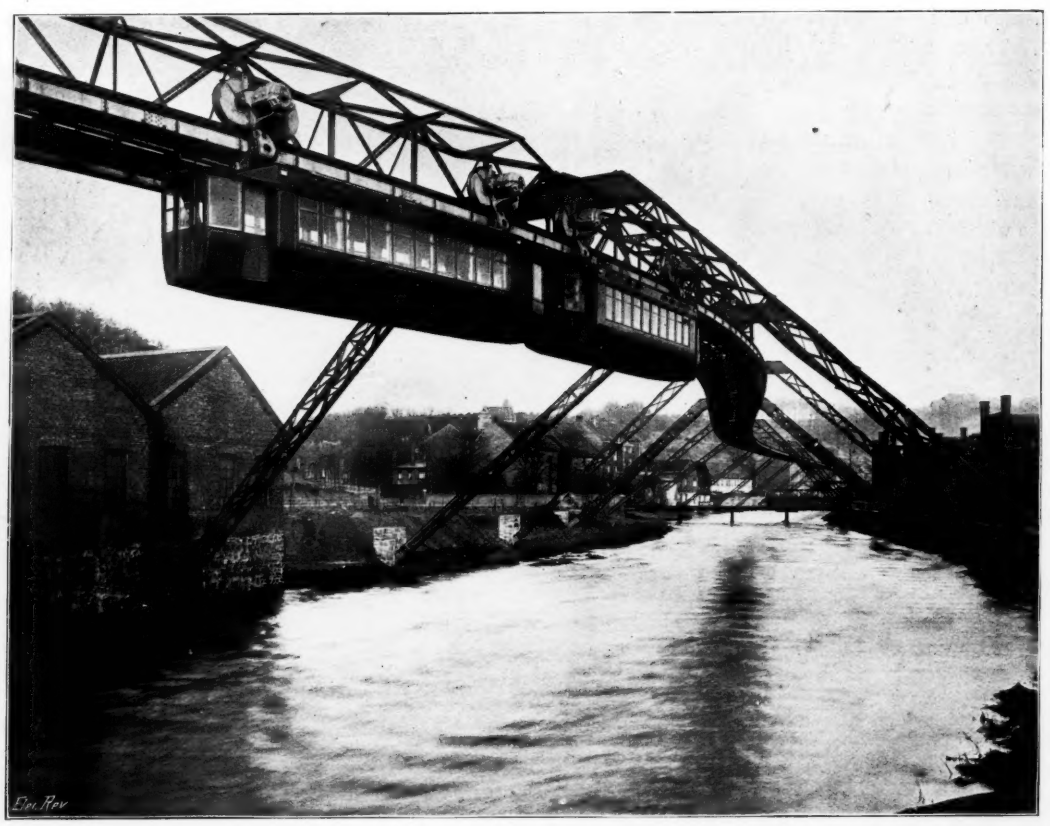
The lower edge of the cars is everywhere at least 14 or 15 feet above the level of the road, and 10 feet below the rail, which is, therefore, about 25 feet above ground.

The two lines, the up and the down, have only one rail each, supported by an iron framework of a kind hitherto unknown in railway engineering; this consists of a row

of iron girders sustained by supports. These supports are far apart along the river, and, as may be observed in one illustration, are fastened in the river walls as abutments, as piles could not be sunk in the loose river bed. Along the road the supports are arches of sheet-iron resting on concrete abutments. The peculiar form of these supports precluded the use of any other metal than iron.

At each of the termini the up and the down lines are connected with each other so as to allow of a continuous quick succession of trains. As some of the trains will only run between Barmen and Elberfeld, and do not go on to Vohwinkel, a similar arrangement has been introduced at the last Elberfeld stopping place, the Zoological Gardens. There is also a temporary one at the Kluse Bemberg Strasse station, as the whole Barmen section is not yet finished.

The cars depend from the fixed overhead rail by means of two "turntables," fitted with double wheels, and 25 feet apart. By this means the cars can easily pass sharp curves, as they hang freely, and can swing out to a considerable inclination sideways, 15° being allowed on the Elberfeld section. On account of the sharp bends of the Wupper, curves with a radius of nearly 100 yards were requisite. The fixed parts of the turntables, from which the cars are suspended, are so closely connected with the iron support of the rail, that it is impossible for them to leave the line, even if the tire of a wheel or an axle breaks. An electromotor is attached to the upper part of the turntable, and drives the two wheels equally. All the electromotors of a train are managed by a driver in front of the first car. Both an electric brake and a through-acting pneumatic Westinghouse brake, as well as hand brakes, are provided, and may be worked from different parts of the train. A conducting-wire is attached to the iron support of the rail, from which the current is derived. The latter is supplied by the newly-constructed electrical works at Elberfeld, at a mean pressure of 580 volts. The cars are lighted by clusters of glow-lamps, placed in a big globe in the roof. Particular attention has been paid to the points on the line, as the service is so frequent, and an electric automatic patent by the constructors has been adopted. The huge iron pillars supporting the line are placed in pairs in the shape of an **A**, but in crowded parts it has been found more advantageous to make the supporting construction shaped like an inverted **U**. The cars are built on an American model, with through corridors and entrance at the side. There are two cars in each train; the stations, too, are "hanging." The greatest advantage of the system is that it is so cheap, as the track may be constructed up roads and rivers, where no ground need be purchased. Still, such railways may well be considered an eyesore in some parts, though in manufacturing towns, for which they are principally intended, little attention is paid to this drawback. As an illustration of the difficulties of the work of construction, it may be mentioned that some 6,000 engineering designs were required. There are already a railway and an electric tramway between the towns of Barmen and Elberfeld, this making the third connecting link between them. The railway has been constructed by the Continentale Gesellschaft für Elektrische Unternehmungen, of Nürenberg.



Railway Suspended over the River Wupper.

COAL AND ASH HANDLING, AND STORAGE PLANTS FOR ELECTRIC LIGHT AND POWER STATIONS.

II.

We shall now describe and illustrate the coal and ash handling plant which has been erected at the new generating station of the Kensington and Notting Hill Electric Light Company, Shepherd's Bush. The whole of the works have been designed and erected under the direct supervision of Messrs. H. W. Miller, M.I.C.E., and George Schultz, A.M.I.E.E., the joint engineers of this company.

We must remark that the work was carried out in a most expeditious manner, from the laying of the first brick to the commencement of generating current, which was only 12 months. The work included the conveying and elevating machinery and coal storage bunkers which we now illustrate. The coal plant is designed to handle 30 tons of coal per hour, and the ash plant is introduced for the purpose of conveying the ash from the boilers and depositing the same in the ash hopper. Owing to the fact that it is necessary at times to work the coal and ash-handling plants together, it was decided to have separate plants for this purpose. If a tilting

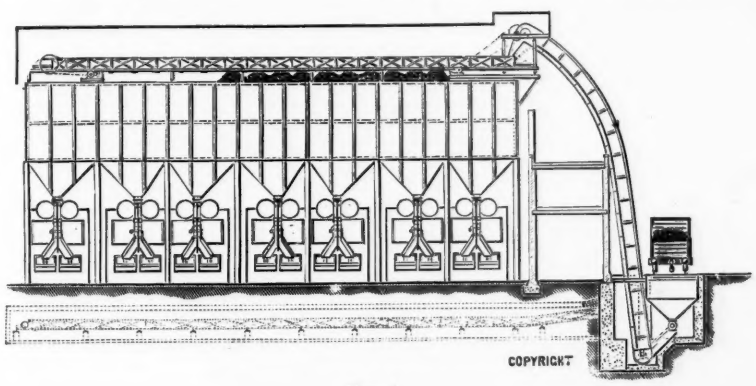


Fig. 4.

bucket conveyer had been adopted it would not have been convenient in this case, owing to the fact of having to receive coal at any moment, and at the same time get rid of the ashes. The coal is brought into the works by railway wagons, which are upended and tipped into a large receiving hopper. Underneath the latter is fixed a Graham's patent revolving feeder for regularly feeding the elevator buckets, in such a way that it is impossible to choke or block the elevator. The feeder is made of a suitable size in proportion to the size of the elevator bucket, to the

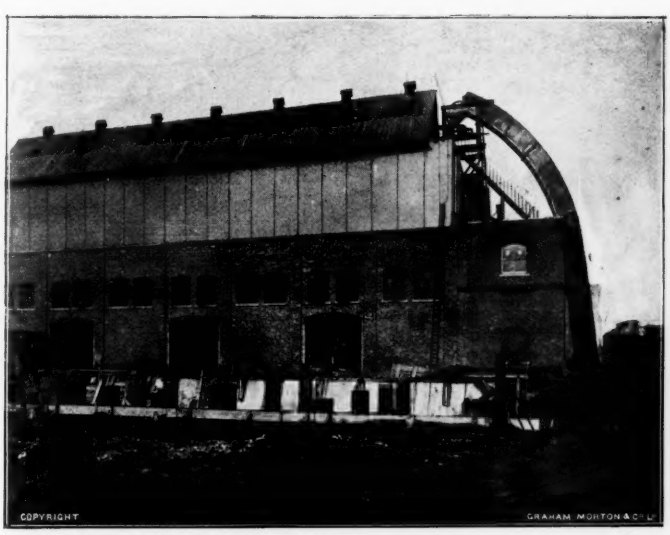


Fig 5.

speed of travel of the elevator and to the quantity handled per hour. These feeders are adopted under large coal stores for automatically emptying them, so that there is no direct thrust or shock given to any portion of the conveying machinery whilst feeding it.

The receiving hopper is 12 feet long × 12 feet wide at the mouth × 9 feet deep, and is made of $\frac{3}{8}$-inch steel plate, joined at the corners by angle irons. Inside the hopper a small screen is fixed, so as to prevent large lumps of coal or pieces of wood or any foreign material from passing through into the elevator.

The latter, as shown on fig. 4 and fig. 5, is a cased-in elevator, the buckets of which are 20 inches wide. The length between centres of sprocket wheels is 75 feet 9 inches. The elevator casing is made of $\frac{3}{16}$-inch steel plate, and the framing of the same is 3 inches × 3 inches × $\frac{3}{8}$-inch angle iron. The guides are made of angle irons fitted with greenheart wood strips, so that the skidders which are fitted to the elevator buckets slide along on this wood liner.

After a short time in working with coal, there is formed on the top of this wood liner a thin coating of carbon, which acts as a lubricator. The elevator is also fitted with an improved roller chain for the purpose of reducing friction.

The coal, on being raised by the elevator, is delivered on to the push-plate conveyer, which is shown on fig. 4. This conveyer automatically distributes the coal throughout the series of large bunkers. The conveyer is 20 inches wide, and 106 feet 6 inches long; it is fitted with the most improved type of pushplates or scrapers and skidder bars.

In the trough of the conveyer is arranged a series of outlets and slides, as shown on fig. 4. The driving and trailing ends of the conveyer are built up of angle and channel irons, and the trailing end is arranged with adjusting screws and cleats for taking up the slack in the chain.

Throughout the whole length of the conveyer a gantry runs, which consists of two angle-iron runners of 4 inches × $2\frac{1}{2}$ inches, secured to steel joist work, and covered with $\frac{5}{16}$-inch wrought-iron chequer plate. The whole of this elevating plant is driven by electric motors.

The large storage bunker, which holds 3,000 tons of coal, is 108 feet long × 17 feet wide × 17 feet deep, and is made of $\frac{3}{8}$-inch steel plates for the sides and ends, and $\frac{1}{2}$-inch plate for the bottom of the tank. The framing of the bunkers consists of 5-inch × $3\frac{1}{2}$-inch × $\frac{1}{2}$-inch tee iron, and along the whole length is rivetted a 4-inch × 4-inch × $\frac{1}{2}$-inch angle iron. Vertical runners and tee irons are also arranged, as shown on fig 4, and to these vertical stays the plates are attached, so

Fig. 6.

that there is a minimum of jointing in the plate work. The general appearance of this large bunker is very substantial.

The bunker is covered by a neat design of roof made of corrugated sheeting, with skylights and ventilators, as shown on the photograph, fig. 5. A wall has now been built which constitutes the front wall of the boiler house, but the skeleton structure of the building is composed of steel joists.

Fig. 6 is a photograph showing the pushplate conveyer over these bunkers. This class of conveyer is largely used in gasworks and collieries where large quantities of coal are

dealt with per hour, and we are informed that conveyers with a capacity of 150 tons per hour are being built on this principle.

Due consideration was given to the weighing or measuring of the coal, and the engineers decided to adopt measuring chambers, similar to those used

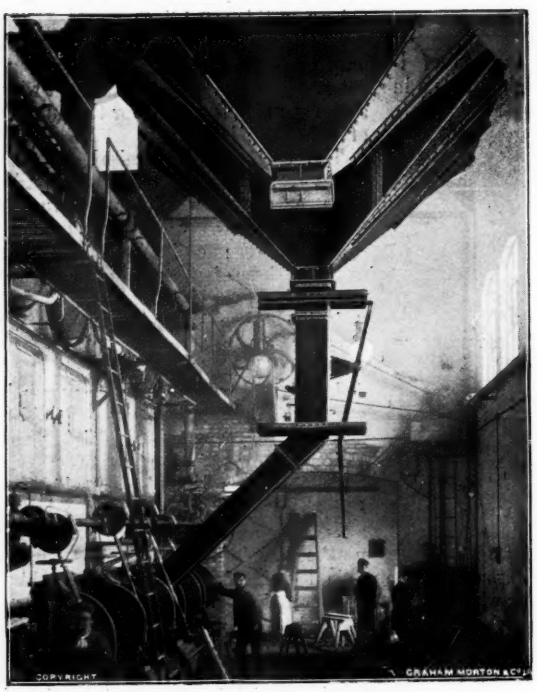


Fig. 7.

in gasworks, but it was found that if these were erected it would be necessary every time that the boiler tubes were taken out to take down the whole of this apparatus.

Fig. 7 shows a photograph of the measuring chambers as now erected. It will be seen that the top valve of the

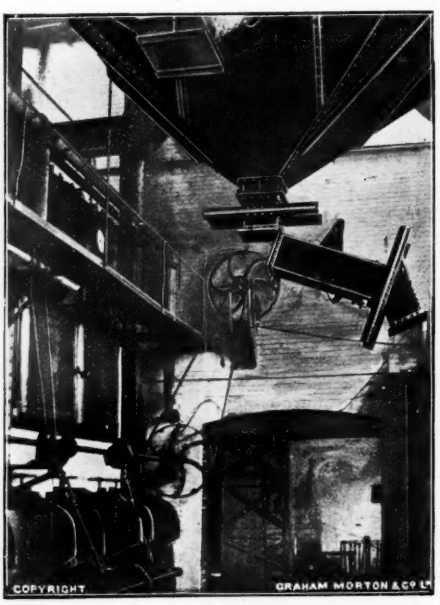


Fig. 8.

measuring chamber comes underneath the joint to the coal bunkers and that underneath the valve, the measuring chamber is swung by means of a hinge. This improvement has been made the subject of a patent by Messrs. Miller and Graham. The measuring chamber is on the "shot pouch" principle, *i.e.*, when the top door is open the bottom door is shut. At the bottom of the chamber is fitted Graham's patent "sure feed check," the object of which is to ensure the chamber being filled, so that the proper quantity of coal is registered on the indicator every time the valves are opened. The two doors are shown connected by one main lever, which is operated from the floor.

The accuracy of measurement *versus* weight was tested for a whole year in one of the largest gasworks, and

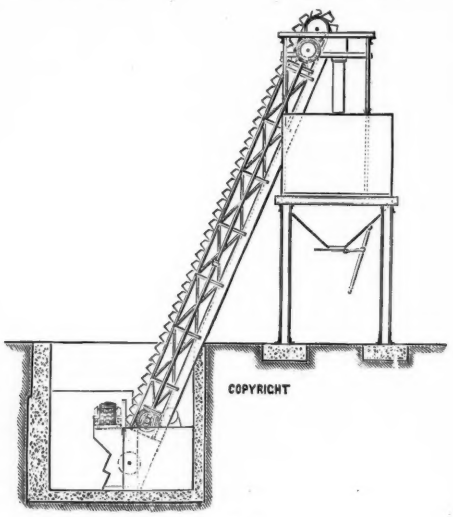


Fig. 9.

was found not to vary more than a trifle, quite near enough for practical work.

When a different quality of coal is used in the boiler house, a record is first made of the weight of coal which the chamber will hold.

Fig. 8 shows a photograph of the measuring chamber

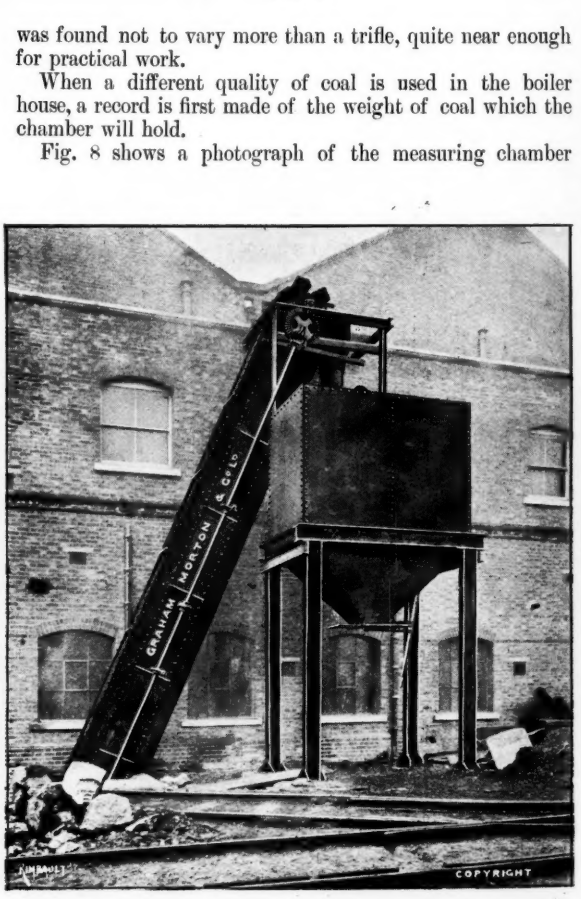


Fig. 10.

swung out of position to allow of any repairs being done to the boilers.

Underneath the charging floor of the boiler house a tunnel has been built in which is fixed the ash conveying plant; fig. 4 shows the design of this as erected. The boilers

were erected by Messrs. Babcock & Wilcox. The ash is delivered by the moving fire bars into a hopper at the back of the furnace and conducted by means of a shoot to the ash conveyer.

The ash conveyer is 18 inches wide, with trays 4 inches deep. The length of the conveyer is 124 feet, and the framework is built up of 4-inch by 2½-inch angle irons. The driving and trailing ends are built of similar design to the other conveyer, with the necessary adjusting screws. There is a difference of design in the chain of this class of conveyer, in which cast-steel links are used, owing to the chain having to run over fixed roller bearings. The speed of the conveyer is about 43 feet per minute, and the ash is delivered at the end into a small hopper, as shown in fig. 9, which is fixed to the boot of the ash elevator.

The elevator is what is known as an 18-inch continuous-bucket elevator, and the buckets are fitted so that they overlap one another and prevent the material from passing through into the sprocket wheels or gearing. The elevator is cased in all round, as shown in the photograph, fig. 10, for the purpose of preventing the rain from filling the buckets. The ash is deposited in the ash hopper, which is shown on the photograph. This hopper is 10 feet long × 8 feet deep × 5 feet 6 inches wide, and is built of $\frac{5}{16}$-inch side plates and $\frac{3}{8}$-inch bottom plates; it will hold 10 tons of ash. The structure supporting it is steel joist work.

This plant was made and erected by Messrs. Graham, Morton & Co., Limited, Leeds.

NOTES.

(*Continued from page* 204.)

An American Tribute to the Late Queen.—The sympathetic feelings of most Americans with the English nation in the sad loss sustained by the death of the Queen have not been confined to the President or to public dignitaries, but such expressions have been finding their way into ordinary commercial correspondence in a very touching way. One instance among many we may quote. A large firm of New York exporters in a communication to a London firm of electrical suppliers wrote as follows:—

> We must let you know that the heart of every true American beats time with that of every loyal Britisher in mourning the death of your Queen. Of her alone, in the history of the world, can this be said, and it speaks for the advancement of humanity as truly as it does for her own worth and ideals. The sense of sorrow must and should give way to one of sweet memory, and inculcate an inspiration throughout the world to higher and nobler spirit in mortal man. The Queen, though dead, will always live in the hearts of those who had grown to love her, and is assured the honour and respect of all future generations. The civilised world to-day sorrows at the passing away even as it rejoices in the life of Her Majesty, who wore not only a crown of gold, but one of truest womanhood. Words are paltry things in dealing with this subject, but please accept them as at least an echo of your own and better appreciation of the occasion.

Visiting the States.—The *Electrical World* says that Mr. James Tatlow, chief engineer of the mechanical department of the Lancashire and Yorkshire Railway, one of the big North of England roads, accompanied by Chief Civil Engineer Worthington and Goods Traffic Manager Hauxwell, of the same system, are now in the States for the purpose of looking into the question of cost in running the various electric roads in the United States. The directors of the Lancashire and Yorkshire line are considering the advisability of adapting electric motive power with a view to handling their suburban traffic, particularly between Bolton and Manchester, a distance of 12 miles. The English engineers were to inspect the several electric systems in Philadelphia, Baltimore, Pittsburg, Chicago, Milwaukee, St. Paul, Buffalo and Boston, and to return to New York about February 20th.

Award.—The Liverpool Engineering Society will award the "Derby" gold medal to Mr. T. L. Miller, M.I.C.E., M.I.E.E., for his paper entitled "Electrical Distribution in Cities," read last February.

Design of Central Electric Generating Stations.—Mr. R. A. Chattock, M.I.E.E., the Bradford city electrical engineer, gave a lecture to the members of the Bradford Scientific Association at the Mechanics' Institute on the 8th inst on "The Design of Central Electric Generating Stations." In the course of his address Mr. Chattock remarked that his subject was of especial interest at the present time in view of the large extensions that were now being carried out at the electricity works of the Bradford Corporation. If an area of supply was not large and the population was fairly dense the most suitable form of supply was by direct current. Direct current could be supplied economically on the three-wire system, at a pressure of from 400 to 500 volts for a distance of about three miles, and this method lent itself to the supply of motive power more satisfactorily than the alternating current; the motors were more easily manipulated and were cheaper in first cost than motors using alternating currents. If, however, the area was large and the population scattered, it was necessary to supply current at high pressure, from 2,000 to 5,000 volts, or even higher, and to transform it down again at various points. If a direct current supply was to be used, the site should be as central as possible within the area of supply, in order to reduce the lengths of the various feeders and ensure efficient working. It might be laid down as a general rule that it was far more economical to put down one large central station than several small ones, and consequently the area of the site chosen should be large enough to provide for the total expected power required, with allowance for stores, workshops and offices. In the early days of electric lighting, a mistake was almost invariably made in not allowing sufficient space for extensions, and experience had proved that it was the best policy, if land could be obtained at a fairly reasonable rate, to buy even five or six times the amount required at the moment, and if possible to let it on short tenancies, so that it was always available when required. The arrangement of the various portions of the building was explained in detail, and various points were illustrated by means of lantern pictures. After discussion, a vote of thanks was accorded to Mr. Chattock for his lecture.

Gas and Water Pipes and Earth Returns.—The secretary of the London Chamber of Commerce sends us a copy of a circular referred to by Mr. George Livesey at the meeting of the South Metropolitan Gas Company last week on the subject of contemplated actions by the gas and water companies in connection with the "Joint Committee's Clause" on earth returns. The circular was sent to promoters of tramway and light railway Bills and provisional orders, through the medium of the Electrical Trade Section of the Chamber, and it merely supports regulations already laid down by the Board of Trade after full discussion and inquiry, which it is desirable to have embodied in any regulation during the coming session. Such regulations were only arrived at by a Joint Committee of both Houses after hearing the fullest representations from the gas, water, and electrical interests. It appears that an attack is now being made upon the electrical industry by the gas and water companies, and not *vice versâ*, as suggested by the published reports of Mr. Livesey's speech. So far from the Chamber being only willing to "take up the cudgels on behalf of one particular industry," we understand that if the gas and water companies wished to utilise the machinery of the Chamber in the same way as its electrical section has done, similar facilities would be afforded to them, as the organisation of the Chamber expressly provides for the furtherance of sectional interests when desired.

The Embankment Lighting Installation. — On Saturday evening Mr. W. H. Dickinson, chairman of the L.C.C., will formally open the electric light installation, which the Council has laid down on the Victoria Embankment for the lighting of the Embankment and Westminster Bridge. The Council on Tuesday adjourned a proposal to appoint a resident foreman for the generating station on the Victoria Embankment.

—"**Economy in Electric Light!**"—Such is the headline of a leaflet in which are set forth the merits of a wonderful invention designed to give "increased light at less cost." The idea is so simple that everyone will want to kick himself for not thinking of it before. Quoting from an alleged "Translation from MODERN ELECTRICIAN," whatever that may be, "The composition contained in this useful tool occasionally applied to the contacts of the lamp promotes COMPLETE CONDUCTIVITY, OBVIATES CONTACT RESISTANCE, REDUCES RAPID EXHAUSTION, which means INCREASED LIGHT and no CURRENT WASTAGE." The "useful tool" is a "stylus," which contains sufficient composition to treat 150 16-C.P. lamps, and should be used monthly during the lighting season; the size of the lamp doesn't matter. The instructions are:—"Disconnect the lamp from the Holder, remove all dust particles, dip the Stylus Composition in a little water and RUB LIGHTLY on the two small brass contacts at the top of the Lamp—replace and switch on as usual." This we did, but the application had no effect on our obstinate lamps. The composition, a small rod about 1¼ inches in length, looks and smells like glycerine soap; and on applying a match it frizzles up. It is, however, an insulator in itself, as was shown by cutting two very thin slices off the end of the "Stylus," and placing them on the lamp contacts, when the lamp refused to glow until the waxy mess was broken through. By placing a slice in the circuit of a battery and electric bell, the latter was silenced. Truly the prospects before the Nernst and other new lamps might be sadly clouded were it not for one sentence, pregnant with subtle meaning—"*Consumers will realise the value of the Stylus after one trial!*"

Electric Traction in London.—Electric traction is a card which the Progressive party are making a great deal of in connection with the approaching election of the L.C.C. One of the "Progressive" daily papers argues that now's the time for a real decisive vote of confidence in the "London policy as opposed to the policy of private interest and private enterprise." One might almost imagine that all electric tramway systems owned by private companies were sinful failures, while the great boon of municipalisation left nothing to be desired. The provision of the Liverpool municipal system of trolley lines is held up as an example, but the *Daily News* writer prefers not to mention the large networks of trolley lines at Dublin, Bristol, Middlesbrough and other places where systems carried out by companies have conferred enormous benefits upon the citizens. We quite agree that the present state of the London tramways is nothing short of a disgrace when we compare it with those of other large cities, but as we have said before, the L.C.C. (and very largely the "Progressive" party) have themselves to blame for preventing private individuals or companies from working the lines electrically some years ago. Had these been allowed their way we should not need to go so far as Liverpool to find an example of how to do it. Party organs are accommodated with short memories on occasions (not always due to change of editors), but seeing that the L.C.C. has already got possession of many miles of lines, and is bound to a policy of electrification forthwith, it seems a pity that the matter of electric traction should be made one for party cry. We are not concerned with the success or failure of either party as such. What we want to see, and that without any further delay, is a complete system of electric tramways in operation in London. It will be a boon to the general public, and a blessing to the electrical engineering industry.

Tramway Exhibition and Congress, 1902.—As has already been intimated in our columns, the Union Internationale Permanente de Tramways have accepted the invitation of the Tramways and Light Railways Association to hold their congress in London next year. The reception dates are July 1st, 2nd, 3rd and 4th, 1902. Arrangements are also being made for holding at the same time a light railways exhibition in London under the management of the *Tramway and Railway World*, who so successfully piloted the Exhibition of 1900 at the Agricultural Hall. Mr. N. A. Thompson, the secretary of the Tramways and Light Railways Association, is inviting members of his Association to become members of the Union Internationale.

Electrical Engineer Volunteers.—It has been announced that Captain A. Bain, Electrical Engineers, Royal Engineers (Volunteers), is granted the temporary rank of Major in the Army whilst serving with the Volunteer Section in South Africa.

The following officers are granted the temporary rank of Captain in the Army whilst serving with the Volunteer Section in South Africa:—Captain J. J. F. O'Shaughnessy and Lieut. the Hon. R. Craven; and Lieut. J. E. Pearce and Second Lieut. E. H. Leaf are granted the temporary rank of Lieutenant.

A Chelmsford paper says that the Electrical Volunteers, numbering about 100, have begun training at the headquarters in London previous to sailing for the seat of war. Captain D. Brady, R.E., Adjutant to the Electrical Engineer Volunteers, is to go with the Company, his duties as Adjutant at home being meanwhile discharged by Captain H. M. Leaf.

The Commander-in-Chief has approved of officers of the Electrical Engineer Volunteers, who have rendered good service in South Africa, being granted, at the close of the war, honorary rank in the Army corresponding to the rank held while on active service.

Water-Tube Boilers.—Prof. Hudson Beare, of University College, London, has arranged for a special course of lectures on water-tube boilers and the principles underlying their construction and working, which will be held at University College shortly. The lectures are to include a short historical notice of the development and introduction of the water-tube boiler, a discussion of the great importance of good circulation in water-tube boilers, and of the value and efficiency of heating surface and its relation to grate surface. All the better known types of water-tube boilers, both for electric lighting and other purposes, are to be fully described, together with the accessories met with in connection with tubulous boilers. The advantages and disadvantages of the adoption of water-tube boilers are to be discussed, and we understand that the lectures are to be largely illustrated by lantern slides and models. Prof. Beare has secured the services of Mr. Leslie S. Robertson, A.M.Inst.C.E., &c., for these lectures. Mr. Robertson has made the subject of water-tube boilers a matter of special study, and has recently edited the English edition of M. Bertin's well-known book on this subject.

Lectures.—On Thursday last week Dr. Oliver Lodge, the first principal of the new Birmingham University, delivered his presidential address to the members of the Wolverhampton Literary and Scientific Society in the Agricultural Hall, Wolverhampton. Dr. Lodge took as his subject, "Some Recent Discoveries in connection with Electricity and the Nature of Matter."

Before the Edinburgh Architectural Society last week, a lecture on "Electric Power in Buildings" was given by Mr. Wm. A. Agnew.

Prof. A. Jamieson lectured last week at Glasgow, under the auspices of the Springburn Representative Council, on "Electricity."

Appointments Vacant.—The Institution of Electrical Engineers is wanting an accountant clerk at £200 per annum. The Bath City Council wants an electrical engineer at £350 per annum. A clerk is wanted for the Metropolitan Borough of Woolwich, electricity department, at £100 per annum. The Southport Electricity Committee wants a shift engineer and an electrician-in-charge; switchboard attendants and others are required for Hoylake and West Kirby. A shift engineer is required for the Manchester electricity works. An engineer and manager is wanted for the Lincoln electricity works at £300 per annum. See "Official Notices" to-day.

Fatality.—A miner met his death at a Soothill Colliery on 15th inst. by receiving a 500-volt electric shock. At the inquest on Saturday, a verdict of "Accidental death" was returned.

Personal.—Mr. C. F. Metzger, who for some years past has controlled the Bath electricity undertaking, has been selected from 214 candidates to be city electrical engineer for the city of Manchester. Some of our readers will remember the difficulties against which Mr. Metzger had to contend in the old days at Bath, and they will join with us in congratulating him upon his appointment to Manchester, where we have no doubt he will make his influence felt before long.

The Electricity Committee of the Manchester Corporation has appointed Mr. L. D. Price, of the Central London Electric Railway, assistant electrical engineer at a salary of £500 per annum.

The Taunton Town Council has raised the salary of Mr. E. B. Thornhill, from £200 to £300 per annum.

Mr. George W. Smith, who for 30 years has been the manager in France of the Persan works of the India-rubber, Gutta-percha and Telegraph Works Company, has received from the French Government the Cross of the Legion of Honour, and on the 9th inst. about 700 workpeople, as a demonstration of their esteem and affection for their chief, presented him with a cross of that order in brilliants.

Electrical Transmission.—"P. M. H." writes:—"I notice in the article on 'Electric Transmission in Factories and Mills' in the Electrical Review for February 8th, the author of the paper states that 'synchronous motors of the revolving field type are self-starting from rest at light loads, and can be overloaded at least three times their normal load without dropping out of step.' Surely this is incorrect, as all synchronous motors (unless specially designed with copper conductors embedded in the pole-pieces, a system which, I believe, is rarely used) require to be run up to speed by auxiliary means and synchronised with the generator, and I doubt very much whether they will stand three times their normal load without dropping out of step, and would like to hear from some of your readers if they consider this is possible."

Subways for Pipes and Tubes.—The General Purposes Committee of the L.C.C., in the course of a long report dealing with the resolutions passed at the recent Conference of London local authorities on all matters affecting the streets, stated that several authorities had urged that some remedy should be found for the frequent opening up of public ways by water, gas, electric light, and telephone companies. The Conference adopted the following resolutions:—

1. That the Conference is of opinion that in all new leading thoroughfares subways should be constructed in which the water and gas mains, pipes, &c., could be placed.
2. That this Conference is of opinion that the time has arrived for concerted action on the part of the local authorities of the metropolis to remedy the inconvenience, annoyance, loss of time and money now caused by the operations of the gas, water, telephone, and electric lighting companies in laying down, renewing, maintaining, and repairing their mains, pipes, services, and wires.

The Committee recommended that these resolutions should be referred to the Improvements and Highways Committees for consideration and report, and this was agreed to after some observations from Earl Russell who expressed the hope that the Committees would consider the question as to what legislation would be necessary to give effect to the proposals. It might be well, too, to make some provision for imposing a tax upon the companies for each square foot of the street that is open over 24 hours.

Municipal Trading.—Lord Avebury delivered his presidential address at the meeting of the Royal Statistical Society on Tuesday at St. Martin's Town Hall. The subject was "The Growth of Municipal and National Expenditure."

English v. German Trading.—A private letter from a prominent Australian citizen is printed in the *Times* to show how the Germans push trade. We need not quote the details into which he enters, but he sums up by saying:—No wonder that English trade is said to be on the down grade. "Slower steamers, slower railways, and no advertising."

Wiremen v. Carpenters.—The Asylums Committee of the L.C.C. has reported that difficulty had arisen at the Horton Asylum in consequence of the casing and capping in connection with the electric light installation being fixed by wiremen, the Amalgamated Society of Carpenters and Joiners claiming that the work should be done by carpenters. The contractors had been asked to employ carpenters for the work, but in the absence of any stipulation in the contract they had declined to do so, and the Committee were unable to insist upon the contractors complying with their request. Being of opinion that similar difficulties should be avoided in future, the Council decided that the trades to be employed in the more important sections of any works to be carried out under contract should be specified in a schedule to be added to the contract.

Higher Pressure Supply.—In the House of Commons on Monday Mr. G. Balfour said he was informed that the Chelsea Electricity Supply Company, Limited, desired to change their standard pressure from 100 volts to 200 volts, and that in order to induce consumers to take the higher pressure, they had given notice that after July 1st next consumers taking a supply at the lower pressure would be charged a rate higher than that to be charged for supply at the higher pressure. The higher rate was within the maximum price fixed by the provisional order, but whether the company were entitled to charge different rates to consumers supplied at different pressures was a legal question on which he was not prepared to express an opinion. He had no power to give or refuse sanction to the proposed charges.

The Institution of Electrical Engineers.—Last night the Dublin section met by kind permission at the Royal Dublin Society, when a paper was read by Mr. Arthur Jacob, member, on "The Electrical Equipment of the Dublin United Tramway Company's System."

Electricity in the Navy.—On Tuesday, 19th inst., there was launched from Messrs. Palmer's yard at Jarrow-on-Tyne, the first-class battleship H.M.S. *Russell*. This, we believe, is the first ship in H.M. service using electricity at a pressure of 100 volts, the pressure at present in use being 80 volts.

Marriage.—At Bournemouth last Saturday week, Mr. P. J. Pringle, resident engineer for Messrs. Kincaid, Waller and Manville, consulting engineers to the Midland Electric Corporation for Power Distribution, Limited, was married to Miss Beryl Olive Blyth, daughter of the late Sir Arthur Blyth.

Submarine Boats.—It is stated in Paris that the *Goubet*, submarine boat, has accomplished 25 miles an hour on a trial trip with electric accumulators. We beg leave to doubt it.

Newspaper Trolley Cars.—A New York exchange states that a fast trolley car is being tested in Philadelphia. It takes newspapers in the early morning to Chestnut Hill, 14¾ miles away. It runs at a rate of 35 miles per hour, including a stop at least every three-quarters of a mile. It is an experiment made by the Union Traction Company to test the maintenance of high speed and the evenness of schedule time. Every trip is carefully watched by experts—the state of the metal, the thermometrical and barometrical conditions being noted, as well as the humidity and fog at the various stations. Automatic instruments for recording the speed, &c., are arranged on the back platform. The weight of the car, newspapers, and four persons occupying it is 10½ tons.

Electric Waves.—The Rt. Rev. Monsignor Gerald Molloy lectured at the Royal Institution on 15th inst. on the subject of "Electric Waves."

Royal Society.—Among the papers read yesterday was one by Dr. Waller, F.R.S., on "An Attempt to Estimate the Vitality of Seeds by an Electrical Method."

Will.—Lord Armstrong's will, proved in Newcastle, gives the gross value of his estate as £1,399,946.

NEW COMPANIES REGISTERED.

Okonite Company, Limited (69,327).—This company was registered on February 6th, with a capital of £120,000 in £2 10s. shares (32,000 preference) to acquire the undertaking and assets of the Okonite Company, Limited (in liquidation) subject to the debts and liabilities thereof, with the exception of the debentures issued by such company in liquidation, to pay for the same in the manner provided by an agreement with the said old company and its liquidator, and to manufacture and deal in insulated and other wires and cables capable of use for telegraphic, telephonic and other purposes, and for electric lighting and the conveyance of electricity, and to carry on the business of manufacturers of, and dealers in, Okonite and other insulating materials and things used in connection with electricity; also the business of engineers, electricians, merchants, shippers, contractors, &c. The first subscribers (each with one share) are:—H. D. Cheever, 253, Broadway, New York, U.S.A., merchant; W. Holmes, Broad Street House, E.C., solicitor; W. T. Ogden, 6A, Austin Friars, E.C., chartered accountant; J. G. Denyer, 15, Ostade Road, Brixton Hill, S.W., incorporated accountant; A. Keeman, 67, Amhurst Road, N.E., clerk; T. W. Doran, 48, Trinity Road, Wood Green, N., clerk; and M. Foster-Cooper, 57, Moorgate Street, E.C., solicitor. The number of directors is not to be less than two nor more than five; the first are F. C. Hones, H. D. Cheever, W. L. Candee, J. H. Cheever, and W. F. Gaston; remuneration of directors resident in the United Kingdom, £52 10s. each per annum; of those resident in the U.S.A., a share in the profits made in America. No initial public issue. Registered office, 6A, Austin Friars, E.C.

Plumpton Brothers, Limited (69,310).—This company has just been registered, with a capital of £100 in £1 shares, to carry on the business of electrical engineering in any form whatever, to manufacture every kind of work, engineering or otherwise, whether applicable to electricity or part electricity and part gas or otherwise, to provide and supply electricity, force, light and heat, &c. The first subscribers (each with one share) are:—Thomas Plumpton, 1B, Cooper Street, Manchester, chartered accountant; Miss J. B. Plumpton, 73, Hartington Street, Moss Side, Manchester; Robert E. Plumpton, 73, Hartington Street, Moss Side, Manchester, electrical engineer; Mrs. A. V. Marnell, 17, Walter Street, Chorlton-on-Medlock, Manchester; Miss E. M. V. Plumpton, 169, Albany Road, Camberwell, S.E.; John Plumpton, 73, Hartington Street, Moss Side, Manchester; and Mrs. Mary A. Crowe, 109, Albany Road, Camberwell, S.E. Registered without articles of association. Registered office, 1B, Cooper Street, Manchester.

City and Suburban Electric Carriage Company, Limited (69,349).—This company was registered on February 9th, with a capital of £500 in £1 shares, to carry on the business of cycle, velocipede, cart, cab, wagon, ship, boat, flying machine, carriage, and vehicle builders, electricians, mechanical engineers, machinists, fitters, smiths, wire drawers, tube makers, metallurgists, saddlers, rubber manufacturers and merchants, oil refiners, galvanisers, japanners, electro-platers, ironmongers, carpenters, joiners, packing case makers, suppliers of power, traction, light, and heat, &c. The first subscribers (each with one share) are:—G. F. Seagrave, 69, Falkland Road, Horusey, N., accountant; H. H. Fox, 2, Brick Court, Middle Temple, E.C., solicitor; E. Wallace, 56, Mornington Road, N.W., law stationer; J. B. Taylor, 40, Patshull Road, N.W., clerk; J. P. Eldridge, 16, Marlborough Road, Bowes Park, N., shorthand writer; F. W. Sumpster, 14, Gerrard Street, Islington, N., shorthand writer, and L. Rendell, 5, Hanover Mansions, Maddon Street, W., solicitor. No initial public issue. Registered without articles of association.

Beck & Moss, Limited (69,298).—This company was registered on February 1st, with a capital of £2,500 in £1 shares, to acquire (1) the customary fee of Faraday Works and premises of and belonging to William Moss, of Howard Place, Hanley, Staffordshire, electro-metallurgist, situate in Cannon Street, Hanley, aforesaid; (2) the goodwill of the business of electro-metallurgists carried on by the said William Moss and Karl P. Beck, under the style or firm of "Beck & Moss," at Faraday Works, Cannon Street, Hanley, aforesaid, with the trade marks, patents, rights, stock, plant, machinery and effects of the said business; (3) the goodwill of the business of electro-metallurgists carried on by Joseph B. Parry and Richard Larsen, under the style or firm of "Larsen & Co.," at Elm Street, Hanley, aforesaid, with the trade marks, rights, patents, stock, plant, machinery and effects of the said business, and to carry on the business of electro-metallurgists, electro-typers, electro-platers, enamellers, fitters, electrical and general engineers, cycle platers, nickel-platers, steel-facers, electro-chemists, metal-mounters and spinners, art metal workers, &c. The first subscribers are:—William Moss, Howard Place, Hanley, electro-metallurgist, with 700 shares; Karl P. Beck, Cannon Street, Hanley, electro-metallurgist, with 600 shares; J. B. Parry, Trinity Street, Hanley, auctioneer, with 300 shares; R. Larsen, 11, Brunswick Place, Hanley, electro-metallurgist, with 425 shares; F. A. Groom, 9, Gill Street, Hanley, builder, with 50 shares; S. A. Green, Well Close House, Fenton, cashier, with 100 shares; and G. G. Quinn, Meaford Hall Farm, Stone, science teacher, with 100 shares. The number of directors is not to be less than three nor more than five; the first are William Moss, Karl P. Beck, Joseph B. Parry, Richard Larsen and Henry Howlett; qualification, £200; remuneration, £5 each per annum. Registered office, Faraday Works, Cannon Street, Hanley, Staffordshire.

Braby & Tomlinson, Limited (69,338).—This company was registered on February 8th, with a capital of £10,000 in £10 shares (900 preference), to acquire the business of electrical engineers and contractors, heretofore carried on at 15, Hart Street, Bloomsbury, W.C., by Messrs. Pritchetts & Gold, and to carry on the business of electrical, civil, mechanical, sanitary, gas and water engineers, electricians, contractors, suppliers and fixers of lamps, motors, bells, telephones, telegraphs, speaking tubes and other apparatus and things, &c. The first subscribers (each with one share) are:—I. Braby, Bushey Lodge, Teddington, electrical engineer; E. T. Tomlinson, 8, St. George's Square, S.W., electrical engineer; A. Child, Butler Road, Harrow-on-the-Hill, gentleman; W. Braby, 1, The Chestnuts, West Heath, Hampstead, zinc merchant; H. C. Winchworth, 11, Old Steine, Brighton, gentleman; E. Morgan, 13, Highcroft Villas, Brighton, electrical engineer; and N. Braby, Bushey Lane, Teddington, artist. No initial public issue. The number of directors is not to be less than two nor more than seven; the first are I. Braby, E. T. Tomlinson, and another to be appointed by them; qualification 40 shares. Remuneration as fixed by the company.

London and Provincial Electric Construction Company, Limited (69,316).—This company was registered on February 5th, with a capital of £75,000 in £1 shares, to apply for, obtain, promote and deal with Acts of Parliament, provisional or other orders, authorities or licenses relating to the incorporation of a company or companies for the construction of underground or overground railways or tramways to be worked by electricity; to oppose any Bills or applications, to adopt an agreement between Louis Bernt of the one part, and Elliot G. Mason (for the company) of the other part, to construct, equip, maintain and work by steam, electricity, cable, or other mechanical power, any railways and tramways, and to carry on the business of railway, tramway, omnibus and van proprietors, electricians, carriers of passengers and goods, locomotive builders, manufacturers of rolling stock, electrical and general engineers, &c. The first subscribers (each with one share) are:—M. E. Williams, Winchester House, Old Broad Street, E.C., solicitor; C. T. Hopkins, Winchester House, Old Broad Street, E.C., clerk; F. W. Merriman, Winchester House, Old Broad Street, E.C., solicitor; C. F. Gillard, 80, Winchester House, Old Broad Street, E.C., clerk; F. Grant, 140, Clyde Road, South Tottenham, clerk; E. R. Maunder, 163, Seven Sisters Road, Holloway, N., clerk; and J. T. Seacombe, 80, Winchester House, Old Broad Street, E.C., clerk. The number of directors is not to be less than four nor more than nine; the first are to be appointed by the subscribers; qualification, £100; remuneration, £150 each per annum, with £100 extra for the chairman, and £50 extra for the vice-chairman.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Pacific and European Telegraph Company, Limited (36,683).—This company's annual return was filed on December 22nd, when the entire capital of £100,000 in £10 shares had been taken up. £4 has been called up on each share, resulting in the receipt of £40,000.

Peru Telephone Company, Limited (29,290).—This company's annual return was filed on January 15th, when 7 shares were taken up out of a nominal capital of £100,000 in £5 shares. No calls.

SUPPLY STATION ACCOUNTS.

Shoreditch Vestry Electricity Accounts.

The 1899 accounts will be the last issued under the title of the Shoreditch Vestry; in future they will appear as the Borough of Shoreditch. The 1898 accounts are overloaded with a mass of detail and ledger entries which were the following year omitted, much improving the clearness of the abstract. As a rule, the more closely the Board of Trade model form is followed the better it is. The capital expenditure has really increased by over £60,000 in 1899, and now stands at £170,000 odd. The output increased over 50 per cent. and load about 45 per cent. The figures all indicate how fertile this portion of Northern London is as an electricity-consuming area.

General Statement.

	1898.	1899.	Increase.
Total capital expenditure ...	£116,032*	**£170,383**	£54,351
Number of units sold	1,031,348	**1,630,426**	599,078
Maximum load in KW.	720	**1,050**	330
Gross revenue	£14,116	**£22,037**	£7,921
Gross expenditure...	£6,300	**£15,899**	£9,599
Gross profit	£7,816	**£6,138**	−£1,678
Average price per unit sold ...	3·12d.	**3·23d.**	+·11d.

* Of this sum £6,909 was transferred to the refuse destructor account, leaving the net capital at £109,123 at end of 1898.

The revenue statement shows the drop of $\frac{1}{10}$d. in the gross receipts per unit, notwithstanding an increase of over $\frac{1}{10}$d. in the revenue for energy sold. This is explained by a diminution of no less than £572 in the monies received from other sources, by which a fall of ·16d. in the receipts was nearly balanced by the improved figure for energy.

The profits from the wiring department were almost wiped out in 1899, the expenditure, &c., being:—

Year 1898.	£	s.	d.
Materials, wages, and supervision paid for ..	3,292	1	0
Less works in hand, 1897	1,041	15	6
	2,250	5	6
Add works in hand, 1898 ..	330	18	3
	2,581	3	9
Less bad debts	32	4	4
	2,548	19	5
Less costs of wages, &c. ..	2,268	6	8
Profit in 1898..	280	13	9

Year 1899.	£	s.	d.
Wiring and fitting work ..	3,480	17	1
Less bad debts	27	2	6
	3,453	14	7
Less costs of wages, &c. ..	3,452	14	1
Profit in 1899	1	0	6

These figures give an idea what is done by a department about which there has been so much talk. In our opinion, unless a fair profit be made, the local authority is entering upon unfair competition with wiring firms.

The sales, &c., for the last three years were distributed as follows:—

Year.	Units generated.	Private supply.	Public lamps.	Number of public lamps.
1897...	491,107	203,504	80,791	57 arcs, 114 32-c.p. incandts.
1898...	1,276,322	892,753	138,595	151 „ 302 „ „
1899...	2,135,191	1,263,663	366,763	169 arcs only

In 1897 the sales did not include the energy used by the lift and fan motors on the destructor. In 1893 this energy was allowed for, and since then the sales include the quantity so used—a perfectly fair thing—but in 1897 no less than 156,725 units, or nearly one-third of the total energy generated, was entered under the head of "Used in works." The quantity now used in works is 479,014, and the quantity not accounted for 25,751 units.

Revenue Statement.

	1898. Gross	1898. Per unit.	1899. Gross.	1899. Per unit.	Increase.
Sale of energy	£13,422	3·12d.	**£21,915**	3·23d.	+·11d.
Meter rents	24	·01d.	—	—	−·01d.
Profit on wiring department..	281	·07d.	**1**	·00d.	−·07d.
Sundry fees: Rents received, refunds and sale of old material	389	·09d.	**121**	·01d.	−·08d.
Gross revenue ...	£14,116	3·29d.	**£22,037**	3·24d.	−·05d.

The cost sheet shows an increase of ·87d. in both works costs and total cost. This is due to coal and repairs, both items being high, even for a metropolitan station. Coal at $1\frac{1}{10}$d. per unit is a revelation to those who heard the sanguine speeches by the late chairman and others at the opening of the works. Nearly £7,700 has been spent in 1899 in fuel, against less than £1,400 the previous year. Evidently the station is ceasing to gain much advantage from its dusty neighbour. Repairs have gone up from a little over $\frac{1}{4}$d. to over $\frac{1}{3}$d.

Cost of Production.

	1898. Gross.	1898. Per unit.	1899. Gross.	1899. Per unit.	Increase.
Coal and other fuel, and unloading same	£1,376	·32d.	£7,694	**1·13d.**	+·81d.
Oil, waste, water and engine room stores	465	·11d.	669	**·10d.**	−·01d.
Salaries and wages incurred in generation and distribution and attendance on street lamps	1,872	·44d.	2,961	**·44d.**	·00d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c., and public lamps	1,208	·28d.	2,408	**·35d.**	+·07d.
Works cost ...	£4,921	1·15d.	£13,732	**2·02d.**	+·87d.
Rent, rates and taxes ..	151	·04d.	466	**·07d.**	+·03d.
Management expenses, salaries of managing engineer, secretary, clerks, &c.	596	·14d.	892	**·13d.**	−·01d.
General establishment charges, stationery and printing, law charges and insurance	575	·13d.	708	**·10d.**	−·03d.
Other expenses: Accident compensation, certification of meters, percentage on "free wired" supply, &c.	57	·01d.	101	**·02d.**	+·01d.
Total costs ...	£6,300	1·47d.	£15,899	**2·34d.**	+·87d.

The gross profit has fallen £1,678 owing to the more than doubling of the expenditure against an increased income of a little over 50 per cent. The financial charges have also shown a remarkable change of £3,348, being £2,226 in 1898 and £5,574 in 1899. Taken at per unit, the figures appear:—

	1898.	1899.
Gross profit	1·82d.	·90d.
Financial charges ...	·52d.	·82d.
Net profit	1·30d.	·08d.

At the end of 1899 a profit of £1,600 is shown in the accounts, as carried forward. This is made up as follows:—

Net profit at end of 1899.—From 1897 accounts ...	£781
„ 1898 „ ...	255*
„ 1899 „ ...	564
	£1,600

* This figure is obtained by adding to the £163 shown in profit statement a sum of £92 given in the 1898 accounts as charges for energy supplied to fan and lift motors in 1897 and not charged for in that year's figures.

Altogether the accounts are very interesting, particularly as Shoreditch is a manufacturing district, and has had a phenomenal electrical growth. We have so often dealt with some aspects of the question in our other columns, that we think the statements now given prove the correctness of views set forth from time to time in the past few years.

Profit Statement.

	1898.	1899.
Interest on loans and overdraft	£1,482	£4,427
Sinking fund for repayments	744	1,147
Net profit carried to reserve fund	1,000	...
„ „ credit of rates	4,427	...
„ „ forward	163	564
Gross profit	£7,816	£6,138

Nelson Corporation Electricity Accounts.

The accounts of the electrical department of the combined gas and electricity undertaking of the Nelson Corporation are attractive on account of the rather remarkable figures presented. All are small, but the costs and return per unit are low, so that we have the exceptional result of a system selling less than 100,000 units annually making a net profit of roughly £300. Mr. Alexander Allan, the engineer and manager of the gas and electricity works, must be congratulated upon these results, but we would suggest to him the propriety of having the financial statement presented in the statutory Board of Trade form, as that adopted is certainly not what the Acts require.

General Statement.

	1898.	1899.	Increase.
Total capital expenditure ...	£10,613	**£11,941**	£1,328
Number of units sold	88,874	**94,643**	5,769
Number of lamps connected ...	6,000	**8,500**	2,500
Maximum load in KW.	112	**119**	7
Gross revenue	£1,703	**£1,828**	£125
Gross expenditure...	£771	**£940**	£169
Gross profit	£932	**£888**	−£44
Average price per unit sold ...	4·47d.	**4·50d.**	+·03d.

The revenue was made up as follows:—

Year.	Public lighting units.	Private supply units.	Total sold.
1898	2,600	86,274	88,874
1899	2,600	92,043	94,643

The prices charged are 5d. for lighting and 3d. per unit for power. The public lighting is at present represented by two arcs of 10 amperes, and two of 15 amperes. It will be seen that the receipts per unit for energy remain about the same figure as in 1898. The gross return of under 4$\frac{3}{4}$d. per unit is most moderate for such a small undertaking.

Revenue Statement.

	1898. Gross.	1898. Per unit.	1899. Gross.	1899. Per unit.	Increase.
Sale of energy	£1,655	4·47d.	**£1,774**	4·50d.	+·03d.
Meter rents	48	·13d.	**54**	·14d.	+·01d.
Sale of lamps, &c.	—	—	—	—	—
Sundry fees	—	—	—	—	—
Gross revenue ...	£1,703	4·60d.	**£1,828**	4·64d.	+·04d.

The coal bill is enough to make engineers' mouths water. Even the rise of nearly $\frac{1}{10}$d. in this item still leaves it well under $\frac{1}{2}$d. per unit, but it seems extraordinary that a works could be run at all on £169 worth of fuel in a year. Naturally wages are high, and here occurs the largest chance of a rise, equalling $\frac{1}{2}$d. Taking a slight improvement in the amount for repairs, we find the works costs has risen by nearly $\frac{1}{4}$d., and almost reaches 2d. per unit, while the appearance in 1899 of the new item for salaries brings the total cost up by almost $\frac{1}{5}$d. to approaching $2\frac{3}{8}$d. This figure, however, compares so well with many larger and more ambitious works, that it reflects every credit upon those who have obtained it.

COST OF PRODUCTION.

	1898. Gross.	1898. Per unit.	1899. Gross.	1899. Per unit.	Increase.
Coal	£132	·36d.	£169	·43d.	+·07d.
Oil, waste, water and engine room stores.	44	·11d.	43	·11d.	·00d.
Salaries and wages incurred in generation and distribution.	247	·67d.	343	·87d.	+·20d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	207	·56d.	205	·52d.	−·04d.
Works costs ...	£630	1·70d.	£760	1·93d.	+·23d.
Rent, rates and taxes ..	117	·32d.	126	·32d.	·00d.
Management expenses, salaries of managing engineer, secretary, clerks, &c.	—	—	29	·07d.	+·07d.
General establishment charges, stationery and printing, law charges and insurance	24	·06d.	25	·06d.	·00d.
Other expenses	—	—	—	—	—
Total costs ...	£771	2·08d.	£940	2·38d.	+·30d.

The gross profit has been adversely affected by the increase in costs. On the increase in gross revenue of £125, the extra expenditure was £169, or a difference of £44, which reduced the gross profit from £932 to £888, still a very fair part—almost half—of the gross revenue. The financial charges in 1898 took £583, or at the rate of 1·58d. per unit, and in the next year £599, or 1·51d. per unit. The extra of £16 on the financial charges, added to the reduction of £44 on the gross profit has left the net profit at £289, or £60 less than in 1898. The gross profit represented 2·52d. and 2·25d. respectively in 1898 and 1899, and for these years the net profit was ·94d. and ·74d. per unit sold. All this has been done with plant comprising one 33-KW. and one 44-KW. machine (and a battery giving 88 KW. for three hours) as machinery in the generating station.

PROFIT STATEMENT.

	1898.	1899.
Interest on loans	£326	£342
Sinking fund for repayments	257	257
Net profit carried forward	349	289
Gross profit	£932	£888

CITY NOTES.

Telegraph Construction and Maintenance Company.

THE report for 1900, to be submitted to the meeting to be held in London on 26th inst., states that the accounts for the year show a net profit of £100,196 after charging the interest on the debentures. To this must be added £53,803 brought forward, making £153,999. From this is deducted the interim dividend of 5 per cent., paid July, amounting to £22,410, leaving £131,589 to be dealt with. Of this sum the directors propose to distribute a dividend of £1 4s. per share, together with a bonus of 6s. per share, absorbing £56,025, being at the rate of 12½ per cent., and making, with the amount already paid, a total dividend for the year of £2 2s. per share, or 17½ per cent., leaving £75,564 to be carried forward. The directors propose to add a further £10,000 to the pension fund, established in 1899, for the benefit of the company's staff.

The British Insulated Wire Company, Limited.

THE directors' report for the year ended December 31st, 1900, to be submitted to the shareholders at the meeting to be held at the Adelphi Hotel, Liverpool, on February 25th, 1901, at 12 o'clock noon, reads as follows:—

The directors herewith submit the balance-sheet and profit and loss account for the year ended December 31st, 1900.

The gross profits for the year amount to		£134,226 0 11
To which has to be added the balance brought forward from the previous year		6,432 14 9
Making a total of ..		£140,658 15 8
From this have to be deducted the total cost of administration, legal expenses, patent fees, &c.	£27,908 11 4	
Depreciation off the buildings, plant, and machinery, according to scale	13,098 10 6	
Written off patents	5,000 0 0	
Debenture interest for the year	2,500 0 0	
Interest on preference capital for the year ..	17,987 18 6	
		66,495 0 4
Leaving a balance available for dividend, reserve, &c., of		74,163 15 4
Out of this balance the interim dividend at the rate of 10 per cent. per annum already paid on the ordinary shares absorbs the sum of ..	£12,481 7 9	
And the directors have decided to transfer to reserve the sum of	22,400 0 0	
		34,881 7 9
Leaving a balance of		39,282 7 7
as shown by the accompanying balance sheet.		
The directors recommend that a dividend be now declared of making with the interim dividend already paid a total dividend for the year of 15 per cent. on the ordinary shares,		32,518 12 8
carrying forward to next account a balance of		£6,763 15 4

The amount now transferred to reserve, £22,400, together with the amount received as premium on shares make a total reserve of £200,000. During the year 30,000 preference shares of £5 each have been issued at a premium of 10s. per share, and 30,000 ordinary shares of £5 each at a premium of £5 per share. The premiums thus received, £165,000, together with £12,600 formerly received, make £177,600. The new copper rolling and drawing department is now in active operation, and has fully justified the capital expenditure on these works. It will, however, be necessary to further extend them in the near future. The company has acquired the freehold property commencing at "The Hollies," Warrington Road, Prescot, extending in a westerly direction and giving an important frontage on Kemble Street. The debenture issue of £50,000 matured on December 31st, 1900, but as the directors contemplated in the near future making a larger issue on more favourable terms, arrangements have been made with most of the holders to temporarily extend their bonds to June 30th, 1901. The results of the year's working have been very satisfactory, and the business of the company has considerably increased. Large additions have been made to the buildings and plant, for the purpose of coping with the great increase of the company's business, and the directors have still further extensions in contemplation. Mr. W. Marriner Brigg and Mr. S. Z. de Ferranti, who are the retiring directors, being eligible, offer themselves for re-election. Messrs. Chalmers, Wade & Co., the auditors, also retire, and offer themselves for re-election.

Westminster Electric Supply Corporation.

THE directors' report for the year 1900 reads as follows:—

The supply of current, which on December 31st, 1899, was provided for the equivalent of 421,445 lamps of 8 C.P., had increased by December 31st, 1900, to the equivalent of 469,589 lamps. At the present time there are on circuit the equivalent of 479,056, and applications have been received for a further 7,056 lamps of 8 C.P. The length of roadway in which mains have been laid now exceeds 54 miles, making about 219 miles of ways, into which upwards of 189 miles of copper (strip and cable) have been drawn. Since last meeting the directors have entered into an agreement with the Vestry of St. George, Hanover Square, for lighting the whole parish by electricity. The experimental lamps erected near Victoria Station, which have been in use for some time past, have given great satisfaction. The mains for this purpose are being laid, the lamp-posts are being rapidly erected, and in a short time a considerable section of the area will be lighted by arc lamps. The continued high price of Welsh steam coal has entailed an extra cost of about 50 per cent. for fuel; and has, of course, materially affected the profits of the past year. Since the supply of current has been given at 200 volts, the revenue has also been reduced by the allowance of 8 per cent. to consumers supplied at that pressure. All the consumers, 5,651, with the exception of nine, are now on the 200-volt circuit. During the year, in accordance with resolutions passed at the extraordinary general meetings, ordinary share capital to the amount of £148,100 has been duly issued at par to the shareholders. A large proportion of this sum has been expended on the joint undertaking of the St. James's and Pall Mall Company and this Corporation, in the purchase of lands and erection of works at North Bank, Marylebone. This capital must necessarily, until the opening of the works for supply purposes, remain unremunerative. An interim dividend, at the rate of 10 per cent. per annum, for the half-year ending June 30th, 1900, has been distributed. After allowing for depreciation, sinking fund, &c., the net balance available for dividend is £30,536 19s. 4d., out of which the board recommend the payment of a dividend at the rate of 11 per cent. per annum, less income-tax, for the past half-year, carrying forward a balance of £3,860. The directors regret that during the year, owing to his appointment as Governor of Madras, their colleague, Lord Ampthill, has had to resign his seat at the board. In accordance with Article 127 of the articles of association, they have elected Lord Kinnaird to fill the vacancy. In accordance with the articles of association, two of the directors, Lord Suffield and R. W. Wallace, K.C., retire; but, being eligible, offer themselves for re-election.

STATEMENT OF ELECTRICITY GENERATED, SOLD, &c.—Year ending December 31st, 1900.

Board of Trade units generated.	Quantity utilised. Sold to consumers.	Used on works for lighting, meter testing, &c.	Total.	Quantity expended in distribution. In batteries.	In feeders.	Total.	Total quantity accounted for.	Quantity unaccounted for.	No. of lamps on circuit, December 31st, 1900.
8,618,640	7,281,109	80,265	7,361,374	19,425	971,128	990,553	8,351,927	266,713	469,589

General Electrolytic Parent Company.

THE *Financial News* states that Messrs. Chalmers, Wade & Co., chartered accountants, Liverpool, have made a thorough investigation of the company's financial position on lines laid down by counsel, and the directors submit a revised balance-sheet to January 31st.

The balance at the credit of profit and loss account, as shown in the accounts published last year, has been increased on the revision by £2,535, thus making a total of £59,341. From this sum has been deducted the cash dividend declared on March 21st, 1900, and the surplus of the past year's revenue has been added, leaving a net balance at the credit of profit and loss account on January 31st, 1901, of £49,536. This is represented by £62 in cash and 49,474 fully paid up ordinary shares in the Electrolytic Alkali Company, Limited. The directors recommend that 45,772 of these shares be distributed among the shareholders by way of dividend, at the rate of eight shares in the Electrolytic Alkali Company, Limited, for every five shares held in this company. This will leave a balance of £3,702 in shares and £62 in cash to be carried forward to the next account. The directors are of opinion that very satisfactory progress has been made with the construction of the works of the Electrolytic Alkali Company, Limited, at Middlewich, Cheshire, in which undertaking the company is very deeply interested.

The Windsor Electrical Installation Company, Limited.

THE fifth annual report states that the company's business is steadily progressing. The number of lamps and motors installed on December 31st, 1899, was equivalent to 13,878 of 8-C.P. During the year 3,930 were added, bringing the total to 17,808 at the end of the year 1900, of which 1,083 represent the motor power.

The additions to the mains and machinery during the year have not been large, the expenditure on capital account amounting to £6,764 14s. 4d., bringing the total capital expenditure up to £53,670 3s. 5d. The principal expenditure was on mains, which included a new cable to Windsor Castle, where a considerable number of additional lights have been connected, and also in St. George's Chapel. A new battery of accumulators has also been provided and is now working. This, it is hoped, will be of sufficient capacity to supply the day load, and thereby effect a considerable saving. The net profit for the year is £4,372 11s. 11d., and this would have been considerably increased but for the high price of coal. The favourable feature of the accounts is that over three-fourths of the profit has been earned from the supply of electric current. The total amount of profit available for distribution, including the balance of £690 12s. 3d. brought forward from the previous year, is £5,063 4s. 2d. Out of this the directors recommend the declaration of a dividend at the rate of 8 per cent. for the year, free of income-tax. An interim dividend of 3 per cent. having already been paid, the remaining 5 per cent. will be distributed forthwith. After payment of the dividends a balance of £1,400 14s. 2d. will remain, out of which the directors recommend that the sum of £750 be added to the depreciation, renewal, and reserve fund, and out of the remainder the shareholders will be asked to vote the sum of £350 for directors' fees. The sum of £3,747 9s. 6d. was received during the year, representing the premiums on the issue of the balance of the share capital less expenses, and the directors recommend that £1,500 of this sum be carried to the dividend equalisation account, and the remaining £2,247 9s. 6d. to the depreciation, renewal, and reserve fund, bringing that account up to the very substantial total of £5,919 10s., and the reserve for equalising dividends up to £2,000.

The meeting is to be held at Windsor on Wednesday, March 27th.

Cambridge Electric Supply Company.

THE ninth annual general meeting was held at the offices, Thompson's Lane, Cambridge, last Friday. The report reads:—

Your directors have pleasure in reporting that the progress of the company continues to be satisfactory. During the year 1900 there had been added to the company's mains the equivalent of 2,863 8-C.P. lamps, making the total 30,896. The number of units supplied has been 357,435, an increase of 59,043 or 19 per cent. In spite of the large increase in the price of coal the company has been able to more than maintain its income without increasing the price of electricity. The company, after paying all charges, placing £250 to the extinction of preliminary expenses, £488 14s. 10d. to the extinction of suspense account, and £750 to depreciation account, has a balance of £4,278 10s. 11d., which, added to £210 15s. 2d. brought forward from last year, makes £4,489 6s. 1d. An interim dividend of £1,413 16s. 2d., and interest on temporary overdraft and loan £193 18s. 9d., have already been paid, leaving a net balance of £2,881 11s. 2d., out of which the directors recommend the payment of a dividend of 4½ per cent., making, with 2½ per cent. already paid, 7 per cent. for the year. This will absorb £2,843 2s. 5d., leaving a balance to carry forward, subject to fractional adjustment of income tax, of £38 8s. 9d.

Smithfield Markets Electric Supply Company.

THE annual meeting of this company was held at Winchester House last Friday, Mr. H. S. Leon presiding.

In moving the adoption of the report, the CHAIRMAN said that taking it altogether they would not be dissatisfied with the balance-sheet. The figures in the balance-sheet were for only 12 months, and they had to be compared with the 15 months of the last balance-sheet. The 12 months' business of the past year showed an increase of 6,279 8-C.P. lamps of 57 new customers. There still remained in the markets about 100 new shops to be lighted. When these came on they would be profitable customers, being long-hour consumers, and the machinery was sufficient to enable them to supply all without any further capital outlay. In December they spent about £3,000 upon a new engine and dynamo. This was now running. A new boiler had also been acquired. This new plant was paid for by issuing £3,800 second debentures, raising this issue to £8,000. In future they would limit any further issue of capital only to works which would show a direct and immediate profit. They intended to maintain their equipment from revenue. They had placed £1,000 to depreciation fund and that policy they would maintain. The debit side of the revenue account showed the coal bill at £4,155 for 1900 against £2,600 for the previous period. The board was not responsible for the rise in the price of coal; it was a regrettable incident, and it had occasioned very heavy working expenses. They expected that the price of coal would be something lower in the year 1901 than it was in 1900. They had made no unfavourable contracts, but were buying only for a month ahead. Last year he anticipated that the gross revenue for the year 1900 would be £9,672 and the net expenses at £6,900, but the balance sheet showed them to be very different, the gross revenue being £15,187 and the expenses £10,735. The gross profit was £4,452, and, but for the price of coal a much better result would have been obtained. As to the future, both classes of debentures were well covered, and shareholders might consider that even if they did not receive a dividend for the next few years, the company was being slowly but surely built up on a safe and solid foundation. For the first time since the formation of the company the directors had taken fees.

Mr. SCHENK seconded the motion, and gave figures showing the progress made by the company since it began operations.

In replying to a number of questions, it was explained that the price of coal was £1 per ton in 1899 and £1 7s. in 1900.

The motion was carried unanimously.

The retiring director and auditors were re-elected.

The Bristol Tramways and Carriage Company, Limited.

THE directors' report to be presented to the shareholders at the ordinary general meeting, held at Bristol, on Thursday, states that the gross receipts for the year ending December 31st, 1900, amount to £165,115 15s. 7d., and the working and general expenses and renewals are £110,794 12s. 3d., leaving a net revenue of £54,321 3s. 4d. The following amounts have already been distributed, viz.:—

Interest on 4 per cent. mortgage debenture stock, and temporary loans	£5,985 1 1		
Dividend on 4 per cent. preference shares and interest on calls in advance ..	7,990 16 8		
Interim dividend at the rate of 7½ per cent. per annum (subject to income-tax), for the half-year ending June 30th	17,968 15 0		
		£31,944 12 9	
And it is proposed to appropriate the balance as follows:—			
Dividend for the half-year at the rate of 8½ per cent. per annum (subject to income-tax)	20,187 10 0		
To carry to reserve and renewals funds:—			
Leased premises redemption .. £500 0 0			
Contingencies 1,689 0 7			
	2,189 0 7		
		22,376 10 7	
		£54,321 3 4	

The reserve funds will be increased from £90,444 11s. 6d., at which they stood at the end of the previous year, to £97,228 9s. 2d. The receipts from the tramways department show an increase of £4,270, and those of the carriage department an increase of £2,126. The total number of passengers carried during the year on the company's cars and omnibuses was 26,971,606. The directors are pleased to be able to report the completion of the electrical conversion and extension of the tramways, as well as the building of the central power station and additional depôts, works which have together involved the expenditure of capital to the amount of £650,000, and called for the unremitting energies of the board and their officials over a period of two and a-half years. At the occasion of last year's report it was hoped that this result might be achieved in time to secure the advantage of the summer's working by electric traction, but, in consequence of delay on the part of contractors in the delivery of the plant, the general opening of the new system for public traffic was not possible until the end of December. Bearing this fact in view, it may be regarded as satisfactory that the net revenue account of the year, besides admitting of a slightly improved dividend, is capable of meeting, even in a greater degree than the preceding one, the heavy charge for dividends on temporarily unproductive capital outlay. It is gratifying to the directors to feel assured that the shareholders have good reason to be satisfied with the future prospects of the company. During the year the 25,000 preference shares were fully paid up, and the issue of mortgage debenture stock was increased to £213,100. Since the close of the year the latter has been further augmented by an allotment to applicants from amongst the stock and shareholders, making up the issue to £250,000, the limit for the time being. The directors purpose that the additional capital about to be created shall be issued, by allotment when required, as preference shares, ranking *part passu* in all respects with the existing shares of that class, *i.e.*, with the right to cumulative preferential dividends at the rate of £4 per cent. per annum, payable half-yearly on January 1st and July 1st, and also the right to rank upon the assets of the company, for the amount of the share only, in priority to the ordinary share capital. The directors have to record, with feelings of deep regret, the death of their esteemed colleagues, Mr. William Butler and Mr. Charles Hoskins Low, both of whom had been associated with the administration of the company for about a quarter of a century, Mr. Butler having been chairman from the inception of the undertaking in 1874, and Mr. Low a director for nearly as long a period. Mr. J. Clifton Robinson, C.E., and Mr. Samuel White, have been elected to fill the vacant seats at the board, and the latter appointed managing director in succession to Mr. George White, who has been elected to the chairmanship. Mr. Henry F. Cooper has been appointed secretary. Mr. Joseph Wethered, director, and Mr. Solomon Hare, auditor, retire at the ensuing meeting, and offer themselves for re-election.

Stock Exchange Notices.—The Committee has ordered the undermentioned securities to be quoted in the Official List:—British Columbia Electric Railway Company, Limited, 20,000 ordinary shares of £10 each, fully paid, Nos. 1 to 20,000; and £250,000 4½ per cent. first mortgage debentures of £40 each, Nos. 1 to 6,250. Application has been made to the Committee to appoint a special settling day in and grant a quotation to Edmundson's Electricity Corporation, Limited, 13,363 6 per cent. cumulative preference shares of £5 each. The Committee has also been asked to allow to be officially quoted Edmundson's Electricity Corporation, Limited, further issue of £45,000 4 per cent. first mortgage debenture stock.

Notting Hill Electric Lighting Company, Limited.—An extraordinary general meeting of this company will be held at 140, High Street, Notting Hill Gate, W., on Wednesday, February 27th, at 5.30 o'clock, to pass the subjoined resolution:—

That the Bill which has been introduced into Parliament under the title of the Notting Hill Electric Lighting Act, 1901, be, and the same is hereby approved.

The annual general meeting of the company will take place on March 19th, when the report and accounts will be considered, and immediately after this meeting the special general meeting will be held, to confirm the above resolution.

Meetings.—Several reports of companies and meetings are unavoidably held over until next week.

Prospectuses.—The Central London Railway Company is making an issue of £876,000 4 per cent. debenture stock at £118 per cent. "on behalf of the company and its contractors." The list closes to-day.

The British Electric Traction Company has been inviting subscriptions for an issue of 30,000 6 per cent. cum. pref. £10 shares at a premium of £1 10s. per share. The subscription list closed on Wednesday.

South Lancashire Tramways Company.—A special meeting of the South Lancashire Tramways Company was held at Liverpool on Monday last, at which a resolution was unanimously adopted, approving of the Bill now before Parliament, for the construction of additional lines of electric tramways in South Lancashire to those already authorised.

Brompton and Kensington Electricity Supply Company.—The directors recommend a dividend for the half-year ended December 31st at the rate of 7 per cent. per annum, making, with the interim dividend, 6 per cent. for the year on the ordinary shares, £9,000 being carried to depreciation, suspense and renewal accounts and £488 forward.

The Edison and Swan United Electric Light Company, Limited.—The directors have resolved that a payment on account of the dividend of the current year be made at the rate of 5 per cent. per annum, less income-tax, on the "A" shares for the half-year ended December 31st, 1900. This will work out at 1s. 6d. per share on the partly paid £5 shares £3 paid, and 2s. 6d. per share on the fully paid £5 shares, less income-tax.

W. T. Henley's Telegraph Works Company.—Subject to audit the directors recommend a dividend on the ordinary shares for the past year at the rate of 20 per cent. (less income-tax), less the interim dividend of 4 per cent. paid on September 1st last—payable March 1st, 1901. The dividend for the previous year was 15 per cent.

Metropolitan Electric Supply Company.—The directors have decided to recommend a final dividend for the year ended December 31st, of 6s. per share on the ordinary shares, and 9d. per share on the new shares.

Bank Rate.—As we go to press we learn that the Bank Rate was yesterday reduced from 4½ per cent. to 4 per cent.

TRAFFIC RECEIPTS.

Birkenhead.—For the week ending February 10th the new cars on the New Ferry route carried 38,207 passengers; total receipts, £186 14s. 6d.

Blackburn Corporation Tramways.—The receipts for the week ending February 16th were £387 10s. 0d.; corresponding week last year, £309 17s. 3d.; increase, £77 12s. 9d. Total to date, £2,580 7s. 5d.; corresponding period last year, £2,291 14s. 11d.; increase, £288 12s. 6d. Miles open, 8¼. Partly electrical.

Blackpool and Fleetwood Tramroad Company.—The receipts for the week ending February 16th were £186; corresponding week last year £149; increase, £37. Total to date, £960; corresponding period last year, £970; decrease, £20.

Bristol Tramways and Carriage Company.—The receipts for the week ending February 15th were £3,374 4s. 4d.; corresponding period last year, £2,217 0s. 6d.; increase, £1,157 3s. 10d.

Central London Railway.—The receipts for the week ending February 16th, were £6,131; previous week, £6,129; increase, £2. Total receipts to date (7 weeks), £42,838. Miles open, 6.

City and South London Railway.—The receipts for the week ending February 17th were £2,040; corresponding week last year, £1,160: increase, £880. Total to date, £14,039; corresponding period last year, £7,899; increase, £6,140. Miles open, 1901, 4½; 1900, 3½.

Dover Corporation Tramways.—The receipts for the week ending February 16th were £141 19s. 5d.; corresponding week last year, £147 18s. 8d.; increase, £5 14s. 3d. Total to date, £1,069 8s. 7d.; corresponding period last year, £1,0 8 15s. 2d.; increase, £40 8s. 5d. Miles of track open, 3. Car miles run, 1901, 4,953; 1900, 4,700. Number of cars, 11.

Dublin United Tramways Company.—The receipts for the week ending February 15th were as follows:—D. U. T. Co., electric cars, £3,002 12s. 5d.; ditto, horse cars, —; D. S. D. Co., electric cars, £672 4s. 11d.; total £3 774 17s. 4d.; corresponding week last year—D. U. T. Co., electric cars, £2,710 19s. 9d.; ditto, horse cars, £47 1s. 5d.; D. S. D. Co., electric cars, £529 6s. 8d.; total, £3,287 7s. 10d.; increase, £487 9s. 6d.; aggregate to date, £25,205 14s 7d.; aggregate to date last year, £22,572 13s. 2d.; increase, £2,633 1s. 5d. The mileage worked is 45 miles electrically.—miles by horses, as against 42 miles electrically, 2 miles by horses, for the corresponding period last year.

Liverpool Overhead Railway.—The receipts for the week ending February 17th were £1,424; corresponding week last year, £1,243; increase, £181. Total to date, £10,367; corresponding period last year, £10,140; increase, £197. Miles open, 6 miles 57 chains.

STOCKS AND SHARES.

Wednesday Evening.

The cheerful tone that pervaded markets when last we wrote, is still in evidence, and business is apparently expanding in the investment departments generally. Again has a little South African boomlet helped the Stock Exchange to see, perhaps with premature optimism, the prospects of brisk trade for the next few months. Easier money is also playing a powerful part in assisting the strength of stock and share markets, and investors are gradually unloosening the strings of those purses that the banks have held for so long.

It is distinctly refreshing to find, amongst electricity supply companies, the Metropolitan coming forward with another dividend of 6s. per share, making 12s. for the whole year. Equal to 6 per cent. per annum, the dividend is 1 per cent. above that paid in 1900 for the year ending December, 1899. In the market the achievement is regarded with great satisfaction, so good a showing not having been anticipated for a period that had been abnormally hampered by high-priced fuel, materials and labour. Metropolitan shares are up to 13 on the declaration, and it is rather interesting to recall the fact that last year the highest price recorded was 15¼; in 1899 it reached 20, and in that boom year of 1898, it got as high as 21¾. The latest issued shares are to receive 9d. each as their proportion of dividend, and the price of these, which have only £5 paid up, is 7½.

Brompton and Kensington shareholders will get their regular 6 per cent. dividend in a week or two, and the quotation for the shares has undergone no change. In fact, the supply list is a very quiet one this week, and beyond the advance noticed in Metropolitans, there is no alteration worthy of mention amongst the shares, a fall of 10s. in the St. James's merely representing the dividend deducted on February 14th. Charing Cross and Strand Preference are about ⅛ better, allowing for the shares being *ex* dividend. The Ordinary are unmoved at Mr. Gerald Balfour's statement in Parliament that he had no power with regard to proposals for changing the company's pressure and charges.

The principal event now attracting attention in the electrical railway market is a new issue of Central London 4 per cent. Debenture stock at 118 to the extent of £876,000. Compared with the prices of other home railway Debenture stocks, the issue price looks very cheap, paying no less than £3 7s. per cent. to the investor. But as it will not rank as a Trustee stock, there is, of course, all the difference between Great Western 4 per cent. Debenture (now standing at 136), or London and Brighton 4 per cent. Debenture (in the neighbourhood of 134), and Central London stock of the same denomination. Doubtless it is a fair investment of its class, and the company's shares have enjoyed substantial rises this week notwithstanding the issue. Coal contracts are now being concluded at much cheaper rates than ruled six months ago, and the exceedingly high ratio of expenses on working the "Tube," 58¾ per cent., should be materially lowered in the current half year. City and South London has receded a point on the prospect of a further £300,000 being required, but Waterloo and City stock, *ex* 1½ per cent., has really risen a half. The Euston Road and Hampstead promoters have their work cut out, it is evident, before they can sufficiently overcome local opposition to offer their shares for public subscription with any hope of success.

The effect of the Central London competition is acutely visible in the reports of the two great omnibus companies of the Metropolis, both of which have done badly in the past half year. British Electric Traction shares of both classes have weakened on the issue of 20,000 new 6 per cent. Preference shares of £10 each at £11 10s. per share. They are a capital investment of the second class, and return a very good percentage on the money. So far but a limited market exists in these new shares, the price of which is about ¼ premium. They deserve a higher quotation, and will no doubt get it in time. And talking of Tractions reminds us that shares of the New York Central Railroad, one of America's premier lines, have been rising sharply within the last few days, upon reports that electric traction is to take the place of steam on the company's suburban system. We wonder what effect a similar announcement, were it made, would exercise upon the price of London and North Western stock.

Telegraph stocks and shares are steady. Eastern 4 per cent. Debenture stock is 1 better. Other Far-Eastern descriptions remain unchanged. In the Anglo-American group, the various stocks of the Anglo Company are all quoted *ex* dividend, and mark a slight decline on balance, not surprising in view of the vigorous way in which the prices were put up in the preceding fortnight.

National Telephone Ordinary are a very weak market, no support coming forward when shares are offered for sale. The reduced dividend, rearrangement of capital, and fears of a new issue are largely accountable for this fall, but some there are who profess to discern signs in the company's report of coming trouble with the Government. Manufacturing shares are good, particularly Henley's, to which we drew attention a few weeks since. The price has risen from 14, at which it then stood, to 16, and the dividend recently declared makes no less than 20 per cent. for the year. Telegraph Manufacturing are also better, a sovereign up on the week, and Callender's Ordinary have improved 10s. Edison & Swan Ordinary, on the other hand, are slightly easier. The dividend just announced is at the rate of 5 per cent., instead of the 6 per cent. paid this time last year.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. †	Dividends for the last three years. 1898.	1899.	1900.	Closing Quotations Feb. 13th.	Closing Quotation Feb. 20th.	Business done during week ended Feb. 20th, 1901. Highest.	Lowest.
96,900	African Direct Telegraph, 4 % Debs.	100	...	...	...	99 —102	99 —102	...	...
119,700	Amazon Telegraph 5 % Debs., Nos. 1 to 1,250 Red.	100	...	...	...	60 — 70	60 — 70	...	...
822,700	Anglo-American Telegraph	Stock	£3 9s.	73/6	3½%	54 — 57	53 — 56 xd	53	...
3,088,540	Do. do. 6 % Pref.	Stock	6 %	6 %	6 %	100 —102	98 —100 xd	100½	98¼
3,088,540	Do. do. Deferred	Stock	18s. %	£1 7s.	5s.%	9 — 9½	8½— 9 xd	9	8⅝
44,000	Chili Telephone, Nos. 1 to 44,000	5	3 %	4 %	...	3 — 3½	3 — 3½	...	...
13,333,300$	Commercial Cable	$100	8 %	8 %	...	170 —180	170 —180	...	...
1,589,496£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	102 —104	102 —104	102½	...
16,000	Cuba Telegraph	10	8 %	7 %	...	8 — 9	8 — 9	8 1/16	...
6,000	Do. 10 % Pref.	10	10 %	...	...	16 — 17	16 — 17	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	...	3½— 4½	3½— 4½	...	...
6,000	Do. do. 10 % Cum. Pref.	5	...	...	...	9 — 10	9 — 10	...	...
30,000	Do. do. 4½ % Debs.	50	...	...	...	100-104%	100 —104%	...	...
60,710£	Direct United States Cable	20	3½%	3 %	3 %	10 — 10½	10 — 10½	10¼	10
108,300	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	99 —102	99 —102	...	... 1/8
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	...	146 —151	146 —151	151	147
1,826,888	Do. 3½ % Pref. Stock	100	...	...	...	95 — 98	95 — 98	97	96
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	...	...	...	112 —116	113 —117	114	...
250,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	...	14¼— 14⅜	14¼— 14¼	14⅝	14
50,000	Do. Nos. 250,001 to 300,000 (iss. at £3 pm. all pd.)	10	...	...	...	13¾— 14¼	13¾— 14¼	14	13⅜
320,000£	Do. 4 % Deb. Stock	Stock	...	...	...	110 —115	110 —115	113	.. ⅞
300,000£	Eastern and South African Telegraph, 4 % Mort. Deb. Nos. 1 to 3,000, red. 1909	100	...	...	...	99 —102	99 —102	99⅜	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	...	...	...	101 —104	101 —104%	...	...
180,227	Globe Telegraph and Trust	10	5⅛%	5¼%	...	10 — 10½	10 — 10½	10¼	10
180,042	Do. do. 6 % Pref.	10	6 %	...	...	15 — 15½	15 — 15½	15½	15 1/16
150,000	Great Northern Telegraph, of Copenhagen	10	12½%	...	...	32 — 34	32 — 34	...	.. ⅛
82,000	Halifax and Bermuda Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	99 —102	99 —102	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	...	47 — 51	47 — 51	47	...
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	...	...	...	104 —107	104 —107	...	...
72,680	Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680	1	...	2½%	...	¼— ½	¼— ½	...	...
86,492	Do. do. do. 5 % Pref., Nos. 1 to 86,492	1	4 %	5 %	...	¾— 1	¾— 1	...	...
590,000	National Telephone, 1 to 590,000	5	6 %	5 %	5 %	4⅛— 4⅜	3⅝— 3⅞	4 1/16	3
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	12 — 14	12 — 14	13 1/16	13⅞
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	11 — 13	11 — 13	12	... ¼
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	4⅞— 5⅛	4⅞— 5⅛	4⅞	...
2,000,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	94 — 97	94 — 97	95¾	95
500,000	Do. 4 % Deb. Stock Red.	100	...	...	4 %	98 —101	98 —101	99½	99
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	...	⅞— 1⅛	⅞— 1⅛	...	.. ¼
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	...	...	...	99 —102	99 —102	...	...
11,839	Reuter's	8	5 %	5 %	...	7½— 8½	7½— 8½	7 9/16	...
3,381	Submarine Cables Trust	Cert.	...	...	...	124 —129	124 —129	...	...
58,000	United River Plate Telephone	5	6 %	7 %	...	4⅜— 5½	4⅜— 5½	...	...
40,000	Do. do. 5 % Cum. pref. Nos. 1—40,000	5	...	...	...	4⅜— 5¼	4⅜— 5¼	...	...
179,947	Do. do. 5 % Debs.	Stock	...	...	...	103 —106	103 —106	...	...
171,000	West African Telegraph, 5 % Debs.	100	...	...	...	99 —102	99 —102	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	¼— ⅜	¼— ⅜	...	...
150,000	Do. do. 4 % Debs., 1—1,500 gua. by Braa. Sub. Tel.	100	...	...	...	99 —102	99 —102	...	...
207,930	Western Telegraph, Ltd., Nos. 1—207,930	10	7 %	7 %	...	14 — 14½	14 — 14½	14 3/16	14
75,000	Do do. 5 % Debs. 2nd series, 1906	100	...	...	...	101 —104	101 —104	...	...
348,777	Do. do. 4 % Deb. Stock Red.	100	...	...	...	102 —105	102 —105	...	...
88,321	West India and Panama Telegraph	10	2 %	⅝%	...	⅝— ¾	⅝— ¾	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	...	...	...	6 — 7	6 — 7	...	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	...	...	...	5 — 7	5 — 7	...	...
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	...	...	...	103 —106	103 —106	...	...

ELECTRICITY SUPPLY COMPANIES.

19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	6 %	6 %	6 %	7½— 8½	7½— 8½	...	...
12,000	Do. do. 7 % Cum. Pref.	5	...	...	...	8½— 9½	8½— 9½	...	...
50,000	Charing Cross and Strand Electricity Supply	5	8 %	9 %	9 %	9½— 10⅜	9½— 10⅜	10⅛	...
20,000	Do. do. do. do. 4½% Cum. Pref.	5	...	...	...	5½— 5¾	5½— 5¾	5 7/16	5½
34,000	*Chelsea Electricity Supply, Ord.	5	6 %	6 %	...	6½— 7	6½— 7	6⅞	6 9/16
150,000	Do. do. do. % Deb. Stock Red.	Stock	...	...	...	109 —112	109 —112	...	...
70,579	City of London Electric Lighting, Ord. 40,001—110,579	10	6 %	4 %	...	7 — 8	7 — 8	7¾	7 7/16
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	...	...	13 — 14	13 — 14	...	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	...	...	...	122 —127	122 —127	...	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	*nil*	4 %	...	8½— 9½	8½— 9½	...	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	...	...	11½— 12½	11½— 12½	...	...
200,000	Do. 4½ % Deb. Stock, Prov. Certs (all paid) Rd.	...	...	...	...	106 —109	106 —109	...	...
35,500	Edmundson's Elec. Corp., Ord. Shares	5	7 %	...	...	4½— 5	4½— 5	...	...
75,000	Do. do. 4½ % 1st Mort. Deb. Stock.	100	...	...	...	102 —105	103 —106	...	...
110,000	London Electric Supply Corporation, Limited, Ord.	3	...	...	...	1½— 2	1½— 2	...	...
49,840	Do. do. do. do. 6 % Pref.	5	6 %	...	...	4 — 5	4 — 5	...	...
250,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	98 —101	98 —101	...	...
85,000	Metropolitan Electric Supply, 101 to 62,500	10	5 %	5 %	6 %	12 — 13	12½— 13½	13¼	13
220,000£	Do. 4½% First Mortgage Debenture Stock	...	...	...	...	110 —113	110 —113	...	...
250,000	Do. 3½% Mort. Deb. Stock Red.	Stock	...	...	...	96 — 99	96 — 99	...	...
6,452	Notting Hill Electric Lighting	10	6 %	7 %	...	15½— 16½	15½— 16½	...	...
40,000	St. James's and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½ %	14½— 15½	14 — 15 xd	14⅝	14⅝
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8½— 9½	8½— 9½	...	...
150,000	Do. do. 3½ % Deb. Stock Red.	100	...	...	...	98 —101	98 —101	...	...
12,000	Smithfield Market Elect. Supply, Ord.	5	...	...	...	2 — 2½	2 — 2½	...	...
50,000	Do. do. 4 % Deb.	100	...	...	...	80 — 90	80 — 90	...	...
65,000	South London Electricity Supply, Ord.	5	...	...	...	2½— 3½	2½— 3½	...	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000	5	12 %	13 %	10½ %	12 — 13	12 — 13	12¾	12 9/16

* Subject to Founders Shares. Quotations on Liverpool Stock Exchange.
Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.
Dividends marked † are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES.—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1898.	1899.	1900.	Closing Quotation Feb. 13th.	Closing Quotation Feb. 20th.	Business done week ended Feb. 20th, 1901. Highest	Lowest
		‡							
20,000	British Aluminium 7 % Cum. Pref.	10	...	...	...	8 — 9	8 — 9	...	...
300,000	Do. do. 5 % 1st Mort. Deb. Stock Red. ...	Stock	...	...	...	91 — 95	91 — 95	...	...
45,000	British Electric Traction	10	6 %	...	...	14 — 15	13¼— 14½	13⅞	...
50,000	Do. do. 6 % Cum. Pref.	10	...	...	...	12½— 13½	11½— 12½	11⅞	...
350,000	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	120 —123	120 —123	...	...
85,000*l*	†British Electric Works Co., Ord. £1 shares, 50,001—135,000	...	...	...	...	⅛— ⅜	1/16— 3/16	...	...
50,000	† Do do. 6 % Cum. Pref., 1—50,000 ...	...	...	...	...	½— ¾	⅛— ¼	...	...
500	† Do. do. 4½ % 1st Mort. Deb.	100	...	...	...	95 — 97	85 — 90	...	...
70,000	British Insulated Wire Ord.	5	15 %	20 %	15 %	10½— 11½	11 — 12	...	...
70,000	Do. do. 6 % Cum. Pref.	5	...	...	...	5⅝— 6¼	5⅝— 6¼	...	...
90,000	Brush Elecl. Engine., Ord., 1 to 90,000	2	5 %	6 %	...	1⅜— 1⅝	1⅜— 1⅝	1⅝	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000 ...	2	6 %	6 %	...	2⅛— 2⅜	2⅛— 2⅜	2¼	2 3/16
125,000*l*	Do. do. 4½ % Perp. Deb. Stock	Stock	...	...	...	105 —110	105 —110	...	...
108,710	Do. do. 4½ % Perp. 2nd Deb. Stock ...	Stock	...	...	...	101 —103	101 —103	...	...
30,000	Callender's Cable Construction shares, Nos. 1—30,000 ...	5	15 %	15 %	...	13 — 14	13½— 14½	14¼	13⅝
40,000	Do. do. 5 % Cum. Pref.	5	...	...	...	5¼— 5⅜	5½— 6	5¾	5⅝
90,000	Do. do. 4½ % 1st Mort. Deb. Stock Red ...	Stock	...	...	...	109 —113	109 —113	...	...
206,297	Central London Railway, Ord. Shares	10	...	...	...	8⅝— 9	9¼— 9⅝xd	9⅝	9
78,703	Do. do. Pref. half-shares	5	...	...	...	4⅜— 5¼	4⅜— 5¼xd	4⅝	...
78,703	Do. do. Def. do.	5	...	...	...	3½— 4	4 — 4½xd	...	...
855,000	City and South London Railway	Stock	2⅛%	1⅞%	1¼%	47 — 51	46 — 50 xd	48	47
37,500	Do. do. Ord. shares Nos. 22,501 to 60,000	10	...	...	...	4 — 5	4 — 5 xd	4⅝	...
54,000	Crompton & Co., Nos. 1 to 54,000	3	6 %	7½%	...	3¼— 3⅜	3¼— 3⅜	...	...
100,000	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red	...	...	...	...	100 —103	100 —103	102½	102
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	6 %	6 %	...	1⅞— 2¼	1½— 2	...	...
17,139	Do. do. do. "A" Shares, 01—017,139 ...	5	6 %	6 %	...	3½— 4½	3½— 4½	...	...
344,023	Do. do. do. 4 % Deb. Stock Red ...	100	...	...	...	88 — 90	88 — 90	...	...
100,000	Do. do. 5% 2nd Deb. Stock Prov. Certs. all pd.	100	...	...	...	96 —100	96 —100	...	...
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	...	1⅞— 2⅛	1⅞— 2⅛	2⅛	2 1/16
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000... ...	2	7 %	...	...	2½— 3	2½— 3	2 15/16	...
182,500	Do. do. 4 % Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	101 —104	101 —104	...	...
9,600*l*	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	7 %	...	10 — 11	10 — 11	...	...
30,000	Henley's (W. T.) Telegraph Works, Ord.	5	14 %	15 %	16 %	14 — 15	15½— 16½	16⅜	14¾
30,000	Do. do. do. 4½ % Pref.	5	7 %	...	...	5½— 6	5½— 6	5¾	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	...	...	...	108 —112	108 —112	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	...	20½— 21½	20½— 21½	21⅜	21
300,000	Do. do. do. 4 % 1st Mort. Deb	100	...	...	...	101 —104	101 —104	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	3¼%	3⅜%	3¼%	8⅜— 8½	8 1/16— 8 3/16	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5	...	13¼— 13⅜	13 — 13¼	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	17½%	41 — 45	41 — 45	...	...
150,000	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	...	...	...	101 —104	101 —104	...	...
20,000	Telegraph Manufacturing, Ord. Nos. 1 to 20,000	5	8 %	12 %	...	10 — 11	11 — 12	11¾	11
20,000	Do. do. 5 % Cm. Prf. Nos. 1 to 20,000 ...	5	...	...	...	5½— 6	5½— 6	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	3 %	3 %	3 %	94 — 97	93 — 96 xd	...	...

† Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Brompton and Kensington, 4½ % Debentures of £100, 101—104.
Consolidated Telephone Construction and Maintenance, 3/—4/-
National Electric Free Wiring, 12/6 paid, 7/16—½.
Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 15½—16½.
Do. do. Pref. (£10 pd.), 10—10½.
* From Birmingham Share List.

Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 11—12; 1st Preference Cumulative 6 % £5 (fully paid), 6½—7 Debentures, 101—104. Dividend, 1900, on Ordinary Shares 12 %.
*T. Parker, £10 (fully paid), 16½.

Bank rate of discount 4½ per cent. (February 7th, 1901).

MARKET QUOTATIONS, Wednesday, February 20th.

CHEMICALS, &c.		This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a ,, Nitric	per cwt.	22/-	22/-	..
a ,, Oxalic	per cwt.	32/-	32/-	..
a ,, Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	89/-	89/-	..
a Ammonia, Muriate (crystal) ..	per ton	£33 10	£33 10	..
a ,, ,, ..	per ton	£30	£30	..
a Bleaching powder	per ton	£7	£7	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£17 10	£17 10	..
a Bensole (90 %)	per gal.	7/-	7/-	..
a ,, (50/90%)..	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£25	£25	..
a Lead, Nitrate	per ton	£25	£25	..
a ,, White Sugar	per ton	£31	£31	..
a ,, Peroxide	per ton	£27 10	£27 10	..
a Methylated Spirit	per gal.	2/6	2/6	..
a Naphtha, Solvent (90% at 160° C).	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks..	per lb.	3½d.	3½d.	..
a ,, Caustic (75/80%) ..	per ton	£24	£24	..
a ,, Bisulphate	per ton	£35	£35	..
a Shellac	per cwt.	64/-	64/-	..
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6 5s.	£6	..
a ,, Recovered	per ton	£5 10	£5 10	..
a ,, Lump	per ton	£5	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	£10 15	..
a ,, Crystals	per ton	£3	£3	..
,, Bichromate, casks ..	per lb.	2¾d.	2¾d.	..

METALS, &c.				
b Aluminium Wire, in ton lots..	per ton	£224	£224	..
b ,, Sheet, in ton lots	per ton	£191	£191	..
p Babbitt's metal ingots.. ..	per ton	£80 to £145	£80 to £145	..
c Brass (rolled metal 2' to 12') basis	per lb.	7¾d.	7¾d.	..
c ,, Tube (brazed)	per lb.	10d.	10d.	..
c ,, ,, (solid drawn) ..	per lb.	8¾d.	8¾d.	..
c ,, Wire, basis	per lb.	8¾d.	8¾d.	..
c Copper Tubes (brazed) ..	per lb.	11d.	11d.	..
c ,, ,, (solid drawn) ..	per lb.	10¾d.	10¾d.	..
g Copper Bars (best selected) ..	per ton	£86	£86	..

METALS, &c, *(continued.)*		This week.	Last week.	Inc. or Dec.
g Copper Sheet	per ton	£86	£86	..
g ,, Rod	per ton	£86	£86	..
e ,, (Electrolytic) Bars ..	per ton	£82	£82	..
e ,, ,, Sheets ..	per ton	£90	£90	..
e ,, ,, Rod ..	per ton	£84	£84	..
e ,, ,, H.C. Wire	per lb.	9¼d.	9¼d.	..
f Ebonite Rod	per lb.	8/-	8/-	..
f ,, Sheet	per lb.	5/-	5/-	..
n German Silver Wire	per lb.	1/6	1/6	..
h Gutta-percha fine	per lb.	8/-	8/-	..
h India-rubber, Para fine	per lb.	3/8	3/8	..
i Iron, Charcoal Sheets	per ton	£18	£18	..
i ,, Pig (Cleveland warrants) ..	per ton	46/7	47/-	5d. dec.
i ,, Forgings, according to size	per ton	From £11	From £11	..
i ,, Scrap, heavy	per ton	70/- to 72/6	70/- to 72/6	..
i ,, Wire, galvanised No. 8 ..	per ton	£10 5	£10 5	..
g Lead, English Ingot	per ton	£14 17 6 to £15 2 6	£15 5 to £15 10	7/6 dec.
g ,, ,, Sheet	per ton	£17 15	£17 15	..
m Manganin Wire No. 28	per lb.	8/-	8/-	..
g Mercury	per bot.	£9 2 6	£9 2 6	..
d Mica (in original cases), small ..	per lb.	3d. to 9d.	3d. to 9d.	..
d ,, ,, ,, medium	per lb.	1/9 to 2/9	1/9 to 2/9	..
d ,, ,, ,, large ..	per lb.	3/3 to 7/3	3/3 to 7/3	..
p Phosphor Bronze, plain castings	per lb.	1/0½ to 1/3	1/0½ to 1/3	..
p ,, rolled bars & rods	per lb.	1/1 to 1/4	1/1 to 1/4	..
p ,, ,, strip & sheet	per lb.	From 1/3	From 1/3	..
o Platinum	per oz.	£4	£4	..
p Silicium Bronze Wire	per lb.	10¾d. to 1/1	10¾d. to 1/1	..
i Steel, Magnet, acc'd'ng to desc'p'n	per ton	From £15 to £68	to £40 £68	..
i ,, ,, in bars				..
g Tin, block	per ton	£125 10 to £126 10	£126 to £127	10s. dec.
g ,, foil	per lb.	1/6	1/6	..
n ,, wire, Nos. 1 to 16	per lb.	1/9	1/9	..
p White Anti-friction Metals — "White Ant" brand	per ton	£40 to £70	£40 to £70	..
j Yarns, Cotton, Single 10 lb. b'ndl's	per lb.	9½d.	9½d.	..
j ,, Best Flax, 6 lea.	per lb.	6d.	6d.	..
j ,, Hemp, 3 ply 10 lbs. ..	per lb.	4½d.	4½d.	..
j ,, ,, Russian, 10 lbs. ..	per lb.	5½d.	5½d.	..
j ,, Jute, 180 lbs. rove ..	per ton	£14 10	£14 10	..
k Zinc, Sh't. (Vielle Montagne ond.)	per ton	£21 12 6	£21 12 6	..

Quotations supplied by { *a* Messrs. G. Boor & Co. *b* The British Aluminium Co., Ltd. *c* Messrs. Thos. Bolton & Sons. *d* Messrs. F. Wiggins & Sons. *e* Messrs. Frederick Smith & Co.

Quotations supplied by { *f* India-Rubber, G.-P. and Teleg. Works *g* Messrs. James & Shakespeare. [Co., Ltd. *h* Messrs. Jackson & Till. *i* Messrs. Bolling & Lowe. *j* Messrs. Henry C. Yeo & Co.

Quotations supplied by { *k* Messrs. Morris Ashby, Limited *m* Messrs. W. T. Glover & Co., Ltd. *n* Messrs. P. Ormiston & Sons. *o* Messrs. Johnson, Matthey & Co., Ltd. *p* The Phosphor Bronze Company, Ltd.

THE SCHUCKERT SURFACE CONTACT SYSTEM.

(*Concluded from page* 298.)

In track crossings and points, so-called dummy contacts are arranged, *i.e.*, contact blocks not in connection with the mains.

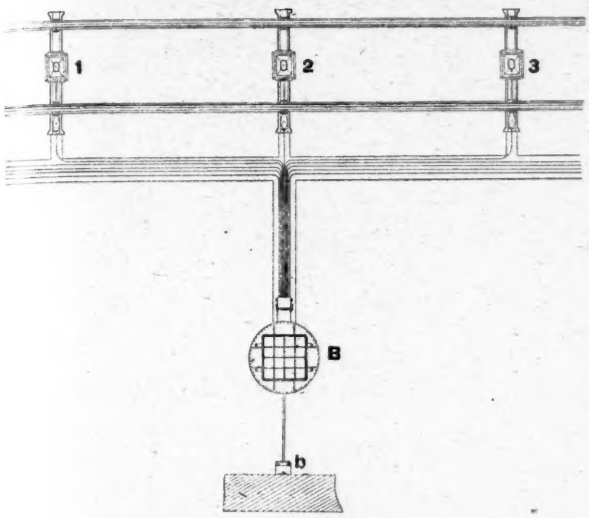


Fig. 5.

These serve solely for supporting the current collector of the car, in order to prevent it from striking on the rails and causing a short circuit.

The connection cable joining the contact blocks to their respective switch mechanisms is laid in a cable trench about 60 to 70 cm. from the rails. The switch apparatus, as already mentioned, is arranged in groups.

As a rule thirty switch mechanisms, of which each serves a separate contact stud, are arranged in one common junction box, as shown in fig. 5.

Fig. 6 shows the cast-iron distribution box open.

Without the use of any packing material, a perfectly reliable hermetic closure is obtained, which, it is claimed, renders impossible the penetration of mud or moisture of any kind.

The relays are attached to a wooden lining arranged some centimetres distant from the iron sides of the box. The air layer thus formed is designed to keep temperature influences from the apparatus as much as possible. The distribution boxes are arranged at distances apart corresponding to the number of their apparatus, *i.e.*, $30 \times 4 = 120$ metres, approximately as possible in the centre of the track.

Fig. 8 shows one of the relay switches. The mode of operation has already been described in the diagram of connections. As will be easily perceived from the drawing, it consists of two magnet pairs arranged diametrically. One pair serves to close the conduit and the other to open it. The coils are provided with shunt winding, taking half an ampere at 500 volts. The cutting out of the relays takes place simultaneously at the moment when the current collector touches the next stud, operating the next switch in such a way that from this switch a current is sent through the pull-off magnet coil of the previous relay.

The relay switch works in precisely the same way as a switch with several contacts, 1, 2 . . . . The lever can be raised sufficiently to clear contact 1, without any sparking taking place. This only occurs when the lever is brought clear of No. 2.

The same switch can be furnished with a safety device, which provides against three series connected apparatus remaining simultaneously active without the automatic cut-out coming into operation.

Should one of the safety devices coming into operation cut off the current from any section, then by merely re-switching in the automatic cut-out it is possible for the traffic to be at once resumed,

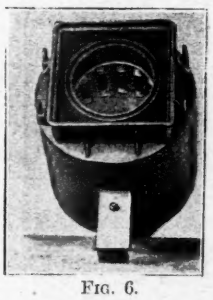


Fig. 6.

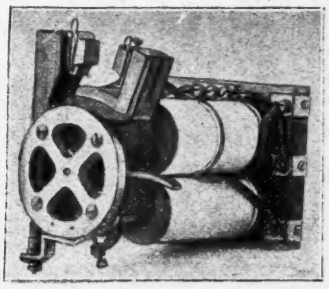


Fig. 7.

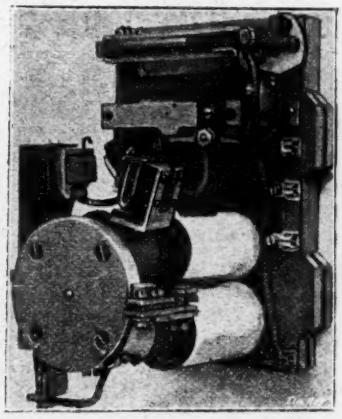


Fig. 8.

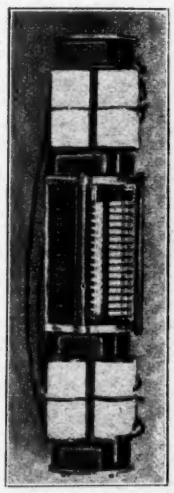


Fig. 9.

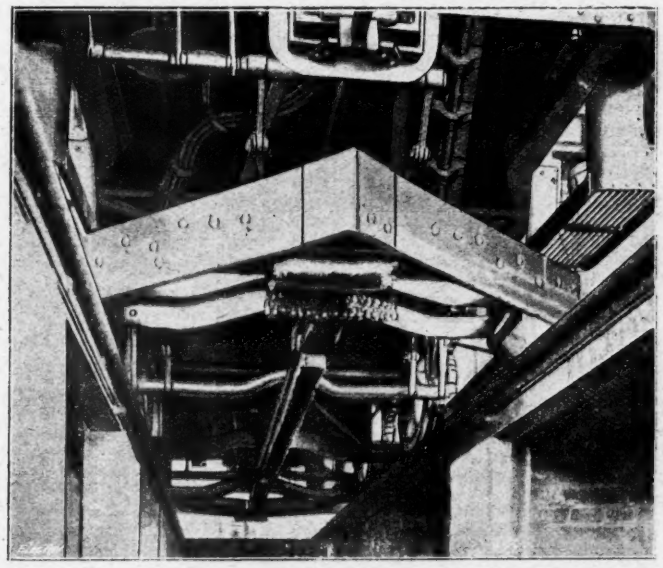


Fig. 10.

provided that the cause of the automatic being called into operation (for instance, the jamming or catching of contact apparatus owing to some mechanical defect) is first seen to. The locking device of the automatic cut-out only permits it to be re-set when all the switching apparatus of the respective sections are inactive, *i.e.*, without current.

The sectional switch, fig. 9, is arranged together with the relay in the distribution box, and it is therefore designed as an electro-magnetic switch. When a motor car travelling an ordinary course passes from one section to another, the current is automatically switched over, as shown in switch diagram, fig. 1, in our last issue.

In changing the travelling direction in the centre of a section, the circuit operating the sectional switch requires to be closed by a hand-switch. These hand-switches are arranged along the track at distances of 60 metres in order to, when necessary, change the travelling direction in the centre of any section.

This switching over is extremely simple, and as the apparatus are always arranged at short distance and can be reached within at most 60 seconds, it is stated that this does not cause much loss of time. The motor car can always travel about three metres in the opposite direction without any switching, which is only necessary for long distances.

In fig. 10 the current collector in the form of a steel wire brush is clearly shown.

These current collectors have worked even with heavy snow and much mud, with absolute safety and satisfaction, and they are perfectly silent.

Before and behind the current collector a wide brush, the so-called "short circuit brush," is so arranged that it connects the rails with the contact stud. The contact studs not covered by the current collector must, as already repeatedly mentioned, be "inactive." Should, however, contrary to all anticipations, an instance occur in which, through some mechanical defect, the relay switch remains in circuit, then the short circuit brush, by connecting it with the rail return, would short circuit the current. This would operate the automatic cut-out, and the traffic on the respective section would be stopped until the defect was remedied. This arrangement is stated to render it impossible that with the Schuckert system a contact stud not covered by the car should remain active, *i.e.*, in circuit.

The weight of the empty motor car, arranged for 32 passengers, and equipped with a Schuckert A.B. 52 motor, is about 6—7 tons. The track consists of Vignoles rails 210 mm. high. Stopping places are provided at the beginning, middle, and end of the respective sections. The section branches off from a line provided with overhead construction.

ELECTRICAL POWER IN BRITISH WORKS.

Read before the Gloucester Engineering Society, February 19th, 1901, by

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It is not without diffidence that I venture to accede to the request of your president, in reading to you a paper on this subject. There have been so many papers on electrical power, most of which have appeared in the Engineering Press, and therefore, no doubt, have been read by you. Moreover, I do not even know whether or not this society has already had this subject under discussion. However, it is a matter of no small importance to British manufacturers, that they should take every possible precaution to adopt the most economical and efficient means of driving their machinery; indeed, statesmen of the highest ability and greatest foresight, such as Lord Rosebery and Mr. Chamberlain, have recently warned us to be prepared in this century for a commercial and manufacturing struggle with other countries, on a scale not hitherto experienced in the century which has just closed.

To this end then let us first consider what are the defects in the existing methods of driving works, and how electricity can be utilised to obviate them.

Older methods of operating important work in vogue in this country may be, broadly speaking, divided into three classes:—

(1) *Works driven by one large engine, from which the power is transmitted by shafting to the various tools.*
(2) *Works driven by separate engines, each receiving its steam through long pipes running from a central bank of boilers.*
(3) *Works driven by boilers and engines scattered over the works.*

Class (1).—In this case the engine should be already operating under the most favourable conditions, viz., with high pressure steam and condensing, which, consequently, cannot be improved upon. On the other hand, the power is transmitted by ropes, belts, or gearing from the engine, by means of shafting, to the machinery, with a loss which may be small or great. I propose then briefly to discuss this

Loss in Shafting.—In some cases where the works are compact and the machines are well placed the loss may be small, as little as 20 per cent. and even less has been recorded; but this is only obtained where the shafting is short, by using great care in the lining of the shaft and adjustment of the bearings and by giving more than ordinary attention to the bearings; it is further only obtained where the shafting and belts are well proportioned to their work and where the load on the machines is constant. In the majority of cases the loss is greater. I found at the Bristol Waggon Works, prior to the introduction of electric driving, it varied from 22 to 57 per cent. and in one case considerably more, while the loss generally was nearer 50 per cent. than 25 per cent. At the Hartlepool Engine Works Sir Thomas Richardson found it to vary from 25 to 70 per cent., the average was 43 per cent. At Furness, Westgarth & Co.'s Engine Works, Middlesbrough, in one shop where two long lines of shafting and a comparatively small number of tools were used the loss was 75·6 per cent.; in two other shops it was 59 and 42 per cent.

In the United States Mr. C. H. Benjamin made somewhat exhaustive tests, from which I have compiled the following table:—

Nature of Work.	Total H.P.	Per centage to drive shafting.	State of load.	H.P. per 100 ft. shafting.	H.P. per 100 lbs. shafting	H.P. per bearing.	H.P. per belt.
Wire Drawing and Polishing	400	39	½	14	·58	1·37	1·76
Steel Stamping and Polishing	74	77	½	9 8	·35	·84	2·4
Boiler and Machine Work ..	38	65	½	4 77	·21	·55	·48
Bridge Machinery	59	81	1	3·28	·14	·34	·52
Heavy Machine Work ..	114	57	1	5·7	·23	·58	·45
Heavy Machine Work ..	168	54	1	8·55	·31	·8	·47
Light Machine Work ..	40	51	1	2·75	·27	·20	·09
Manufacture of Small Tools	74	54	1	8	·4	·69	·12
Manufacture of Small Tools	47	52	1	2·5	·23	·24	·11
Sewing Machines and Bicycles	190	57	1	4·36	·43	·39	·21
Sewing Machines	107	70	1	5 08	·13	·41	·15
Screw Machines and Screws	241	47	1	6·33	·38	·63	·23
Steel Wood Screws	117	14·5	¼	2·53	·11	·18	·13

It will be seen that the loss varies from 14 to 81 per cent., the average in six cases where the machines were doing heavy work being 62 per cent. and in six cases of light work, 55 per cent.; in the former, however, the load was generally variable, while in the latter there was a constant full load. It will be noted that the power transmitted in these tests was comparatively small, generally considerably under 100-H.P. The average H.P. per square foot of shafting was ·046. The H.P. per bearing, column 7, is nearly as great for light as for heavy shafting, probably on account of the greater speed of the former.

It is obvious, other things being equal, that the larger the works and the greater the average distance of the machines from the driving engine, the greater must be the loss in the shafting. It may be expected, therefore, that there are many works where the above losses are exceeded; indeed, it has been stated that in a large cotton mill as little as 1 per cent. of the power of the engine is applied to the cotton itself.

Class (2).—In this case the steam may be economically generated by a central bank of boilers, but it is transmitted through long lengths of piping in which condensation and loss of pressure result, while the engines, apart from using wet steam at a low pressure, are in themselves usually of the most uneconomical type. First, then, there is the

Loss in Steam Pipes.—This is frequently the most serious loss of all; it is one which is not readily appreciated, while on the other hand it is, generally speaking, a continuous loss, not only throughout the day, but also at night. In how many cases is steam shut off the pipe while the engine is not working, where it is the custom for the engine-driver to shut down by the engine, not the boiler, stop valve? More especially does this question apply to engines used intermittently where the loss in the pipes forms an even greater percentage of the comparatively small power used. Further than that, even when the boiler stop valve is closed, how often is it the case that the steam is effectually shut off from the pipes? My experience is that, in the vast majority of cases, the stop-valve leaks and allows the steam to pass into the pipes, so that continual condensation takes place. It is true that the pipes should be efficiently lagged, but even then the loss is considerable, while in most works, where long pipes are used, the lagging is either inferior or there is little or none at all. Roughly speaking, this loss in condensation amounts to no less than the equivalent in steam of half-a-ton of coal per annum per square foot of uncovered pipe surface, if continually under steam, and exposed to the atmosphere, while, with the best lagging, the equivalent is one-sixth of a ton. The importance of this loss is at once apparent if it be remembered that an aggregate pipe surface of several thousand square feet is frequently found in a large works.

Loss in Engines.—Where the engines are small and scattered throughout the works at a distance from the boilers, it is almost invariably the case that they are low pressure, non-condensing engines. They may consume in steam anything from 50 up to 250 lbs. per indicated horse-power per hour. According to Mr. Bryan Donkin, who tested 100 different engines taken at random, the average was 150 lbs. per I.H.P. per hour. Sir T. Richardson stated in a paper read before the North East Coast Institution of Engineers and Shipbuilders that he found the average consumption of 31 different engines in his own works, exclusive of losses in steam pipes, to be 51 lbs. per I.H.P. per hour.

The following table summarises the results of various tests which I made upon five engines which were at the time used to drive the Bristol Waggon Works. The engines varied in size from 100-H.P. to 8-H.P. The results are exclusive of losses in the steam pipes.

Engine.	Lbs. steam per I.H.P. hour.		
	Full load.	Normal load.	Light load.
1	41	46	58·7
2	40	44	47
3	70	96	96
4	34	33	48·5
5	35	32	32

It is probable that in many cases, more especially where the engines are old, in bad condition, with leaky valves and pistons, badly packed glands, no drainage, and inefficient lagging, it will be generally found that the consumption of steam is nearer to the largest of the above figures than to the smallest. (I need not remind the members of this society that modern compound, or triple expansion condensing engines should not use more than 13 to 16 lbs. of steam.)

Class (3).—In this category are included works where separate engines may be comparatively large, each having its own boiler, or they may be small, such as are the engines and boilers found on steam cranes. If the engines are large the probability is that there is excessive loss in shafting, and the fact that the boilers are not banked in one place involves losses in the handling of the coal and in the efficient working and management of the boilers which are obvious. When the engines and boilers are small they are not only most wasteful in coal, but they involve great labour and attention, the upkeep is expensive, in fact, it is almost unnecessary to dilate upon the excessive cost of this system of operating a works.

ELECTRIC DRIVING

We now come to the consideration of the chief subject of this paper, and that is to ascertain how far electricity can assist in overcoming the losses we have discussed. In the first place, I am desirous that you should not misunderstand me, in that it is far from my intention to assert that electricity forms a panacea for all and every case of evil. I have occasionally examined works where there is little or no object in resorting to electric driving. More particularly is this the case where the engines and shafting are new and well designed and the works at the same time are compact. In such case the net gain might not pay a reasonable interest on the cost of making the alteration. There may even be exceptional cases where it would not pay to adopt electricity, notwithstanding that the consideration be made before the works are erected, but I have not yet seen or heard of such a case. Certainly, it is not possible to lay down a hard and fast rule on the subject, for each case must have its own due and full consideration.

In order to facilitate this consideration, let us see what losses take place in the use of electric power, so that we may compare them with the losses already discussed. There is first the loss in the electric generator, which should have an efficiency of 90 to 96 per cent., depending upon the size. Next, there is the loss in the conductors between generator and motor, which depends upon the quantity of copper put into the conductor, on their length, and on the tension of the electricity. In an ordinary works using 200 to 400 volts the loss need not exceed 4 to 8 volts; it might average, say, 2 per cent.

The loss in electric motors, stated as a percentage of full power, varies from about 8 to 25 per cent. The efficiency may be roughly stated as follows:—

100	H.P. motors	92	per cent. efficiency.
50	,, ...	90	,, ,,
25	,, ...	88	,, ,,
5	,, ...	85	,, ,,
2	,, ...	82	,, ,,
1	,, ...	79	,, ,,
½	,, ...	75	,, ,,

It will be seen that the efficiency varies considerably according to size, more especially in the case of the motors, but for the sake of comparison we may take the following as fair average efficiencies.

Generators	92	per cent.
Conductors	98	,,
Motors	85	,,
Total efficiency ..	76	,,

That is, at full load 76 per cent. of the power on the engine shaft is delivered at the shaft of the motor; deducting the friction of the engine, which will absorb, say, 10 per cent., we then have 68 per cent. of the I.H.P. of the engine delivered at the motor shaft; at three-quarter load it would be about 65 per cent., and at half load about 60 per cent. The efficiency of the electric machinery may vary slightly according to its design and the state of the load, but the above results may be taken as a fair average; you will not be far out if you take it that *two-thirds of the* I.H.P. *of the engine is delivered at the shaft of the motor*. We may now, I think, proceed to consider the saving possible in the various cases.

Reduction of Loss in Shafting.—In the case of heavy tools there should be no shafting neces-ary, as each tool would have its own motor. The light tools may also have each their separate motor, but this involves a heavy first cost, and very small motors, as we have seen, are less efficient. It is advisable and customary, therefore, to arrange the lighter tools in groups by means of a limited extent of shafting, operated by a larger motor. For example, whereas 20 machines, each using 1-H.P., require 20 motors, one motor of 10-H.P. may suffice to drive the whole group; thus the length of shafting through which the power passes is generally enormously reduced, while heavy driving belts or ropes, together with gearing, angle or otherwise, may be abolished. The loss then in shafting may be dispensed with in heavy tools and minimised in driving smaller tools. Further, it must be remembered that the motors may be easily switched on and off at will, and that while they are standing there is no loss, whereas in the case of shafting the loss is a continuous one. For machinery working intermittently this is a most important consideration. Take for example the not extreme case where 50-H.P. of machinery is running only half the full time, and that the shafting which drives it is absorbing continually 50-H.P., say for ten hours per drive, there would be 500-H.P. hours lost in the shafting, and 250-H P. hours used by the tools, so that out of 750-H.P. hours two-thirds are wasted in shafting. There are many cases where the hours of use are less than one-half, and where the loss would be even greater. As we have already seen the loss in transmitting the power from the engine shaft to the shaft of the motor is 24 per cent., or less than one-quarter, we are therefore in a position to estimate the saving which may be expected. In some cases it will be seen to be a large one, in others not so.

Saving of Loss in Steam Pipes.—The cables conducting the electricity from the generators to the motors take the place of the long steam pipes appertaining to Class 2. In the first place it must be remembered there is no loss incurred in these cables except during the time the motors are actually in use. Moreover, the loss which takes place is proportional, within limits, to the load on the motors. The actual loss may be made as small as you please by putting in plenty of copper. We have already seen that, at full load, the loss may average about 2 per cent., and for less than full load the loss would be smaller; so that it would appear to be almost negligible, at any rate, unless the works are much more scattered than is usually the case. It may be noted that the loss in the steam pipes cannot be minimised by increasing their size, for whilst increasing the diameter will reduce the loss of pressure at the distant end of the pipe, yet it increases the radiating surface and therefore the condensation, in the same proportion as the diameter is increased.

Saving of Loss in Engines.—I have already given data as to the consumption of steam in first-class engines, such as would be used in driving the generators. I put it from 13 lbs. to 16 lbs. of steam per I.H.P. per hour. You have also seen that 68 per cent. of the I.H.P. will be delivered at the shaft of the motors, so that the steam required per H.P. on the motor shaft would be from 19 lbs. to 24 lbs. per hour. We have further seen that the steam required by separate small engines varies from 50 lbs. to 250 lbs. per I.H.P. per hour, say from 55 lbs. to 275 lbs. per B.H.P. per hour; so that the saving of steam by the use of electricity on this score would be anything from 30 lbs. to 250 lbs. per H.P. hour. When it is remembered that the amount of water evaporated per lb. of coal is from 6 lbs. to 9 lbs., after making allowance for boiler feeding, etc., it will be seen that the saving in coal per H.P. hour may vary roughly from 3 lbs. to 40 lbs. It is true that a consumption of 250 lbs. of steam is an exceptional one; I have only taken so out side a figure because of the authority of Mr. Bryan Donkin, who, as I have already pointed out, has found the average of 100 engines to be no less than 150 lbs. As a rule I should expect to find the saving in coal nearer the smaller figure and somewhere between 3 lbs. and 10 lbs. per H.P. hour. That the saving is considerable has been already demonstrated in a large number of works. At Sir Thomas Richardson's the steam which is now used for driving by electricity is generated by two boilers which have replaced no less than eight main boilers, and 23 auxiliaries that had been necessary on the old system. At the Bristol Waggon Works, five Lancashire boilers were required on the old system, whereas one boiler suffices to drive the works on the electric system.

Saving of Water and Stores.—I have pointed out that with small scattered engines it is generally the practice to work non-condensing, so that the whole of the feed water is probably lost, while we have already discussed the waste of steam in the steam pipes and engines; it will suffice, therefore, to point out that in the case of electric driving by the use of a surface condenser, practically the whole of the water, hitherto used, will be saved, provided always there is a sufficiency of cooling water. The stores, oil, &c., used by one or two large engines are, of course, less than those used by a number of small engines, and the motors should use less oil than the shafting they displace.

With regard to Class 3, the individual losses in the shafting or in the engines may be less, but the total saving should in many cases be quite as much as in Classes 1 and 2. It is true that where the electric generators are working at considerably less than their full normal load, there will be an additional loss depending upon the state of the load. The amount thereof must be determined according to the works under discussion. With small works, or where the motors are large and the work very intermittent, it will be more necessary to consider this than in the case of larger works, where the variations in the loads in the individual departments tend to cancel each other, and produce an even load. One case I have in mind where it was found that, in replacing separate engines aggregating 1,000-H.P., the power of the electric generator, owing to this levelling, was only required to be 250-H.P. I should also remark that, where the load is variable, it is well to specify that the engine and generator shall give its maximum efficiency at somewhat less than full load, say at three-quarter load.

Saving of Labour.—In Class 1 this may be neglected, but in Class 2 it is obvious that more men are required to attend to a number of engines than to one, while in Class 3 there is the further saving of labour involved by the use of boilers scattered over the works, since the firemen are not utilised to their full extent, and there is a further loss of labour in distributing coal and dealing with ashes, &c.

Other Advantages of Electric Driving.

I have already stated that there are cases where it does not pay to adopt electricity on the score of the saving in fuel and in losses in transmission, and that every case must be judged upon the governing conditions. But in making the consideration there are one or two further points to be taken into account. Perhaps the most important is

Increased Output.—It is found in all three classes, more especially in old works, that when the load is thrown on there is a tendency for the speed to fall. In Class 1 the engine itself may be well governed, but slipping of belts may take place through overwork or slackness. It is a common thing to find in works, more especially with main driving belts, that the belts are overloaded; they have probably been put up for a given number of machines and more machines have been thrown on subsequently. Again, in such a works it is frequently necessary to stop owing to accident or breakage in one place or another, which involves the shutting down of the main engine, and consequently the stoppage of the whole of the machinery; this with electric motors is not necessary. In the case of the scattered engines the governing is generally defective and the engines are frequently overloaded, so that throwing on machines may seriously reduce the speed of the rest. On the other hand, the speed of the electric motors is arranged to be correct at full load, and when the whole of the load is switched off the motor the speed should not rise more than 2 or 3 per cent., so that with such a constant speed the tools may be driven at a higher average speed than in cases where a greater variation takes place. That there is an increased output is invariably ascertained by those who have adopted electric driving. Messrs. Richardson estimate that the increased speed and output of their machinery average 20 per cent. This figure also represents the increase which is usually found in printing establishments after introducing electric power.

Facilities of Working.—The electric motor is a comparatively portable article, and the cables by which it is connected to the generator are flexible; consequently in cases where the work is heavy the tools may be carried to the work and thus save the loss of time and labour in moving heavy weights. It has been stated, indeed, that the floor of a modern erecting shop should be one large face plate on which the heavy work is permanently fixed, the tools being brought to the work. The ordinary shop shafting must be laid out so that it is in direct line with the engine, consequently the machines must be placed more with a view to suit the shafting than to handling the work to the best advantage. In the case of new shops, driven electrically, the overhead line shafting may be altogether dispensed with, thus allowing of good light, which is so important; the cranes have free access to the whole of the shops, while the dust, which is set up by overhead belting, is to a large extent avoided. In a rail rolling mill in the United States, where every advantage was taken of the disposal of the machinery when electric driving was adopted, it is stated that the work hitherto done when using separate engines, with 6,000 workmen, is now accomplished with electric power by 4,000 hands.

Facility of Extending.—As further machinery is added on the old system, the make-shift policy of altering the slide valve of the engine to give a later cut-off, is frequently adopted regardless of the ensuing loss of steam, or, to avoid extending the shafting, a new machine may be crowded into an unsuitable position. Electric power is vastly more flexible. An extra motor is easily added when further machinery is put down, so that the machine may be placed in the most favourable position without crowding or overloading and little or no provision need be made in the power of the motor, which may be put down to suit the work immediately in view.

Repairs.—It is difficult to obtain reliable data as to the cost of repairing shafts and belts; certainly the cost of repairs to small separate engines is known to be a considerable item. Generally speaking there should be a saving on this item, more particularly if the motors are well adapted to their work.

It is impossible to cover the whole of the case for and against electric power in the space at my disposal, but in the foregoing I have endeavoured to put before you the more prominent considerations in such a manner as to facilitate your own considerations of each individual case as it may come before you. I will now make a few brief remarks on the subject of

Electric Systems Available.

In the first place, it is necessary to know whether electric power can be obtained from outside; and if so, at what cost. It is probable that in the majority of cases such a supply is already available, while electricity supply works are being rapidly extended throughout all manufacturing districts. In small works, it will always be cheaper to purchase the supply in this way. It may be interesting to you to know that this method is already being largely adopted. I give you the following examples:—

Town	No. of Motors	H.P. of Motors.
Bradford	411	1,636
Edinburgh	385	—
Liverpool	237	770
Manchester	464	1,691
Nottingham	125	450
Birmingham	186	475

The point at which it pays to incur the trouble and expense of having a special generating plant in the works depends upon the amount of power required, and the price for which it can be produced, as compared with that for which it can be purchased. The price charged by the local authorities varies generally between 1d. and 2d. per Board of Trade unit. At Manchester it is 1½d., Edinburgh 1½d., Bradford 1d.

The cost per I.H.P.-hour with a large economical engine should not exceed a quarter of a penny, which is equal to, say, ·375 pence per Board of Trade unit, at the terminals of the generator; this price, however, would be increased according to the price and quality of coal, and as the engines become smaller.

Where it is found cheaper to have an independent plant, I am of opinion that the engines should be of the enclosed type, either triple expansion or compound condensing, and direct coupled to the electric generator. This type of engine is self-oiling, the working parts are mostly lubricated by the splashing of the oil, and there are comparatively few bright parts to be kept clean. With the horizontal, or even vertical, slow speed engine greater attention is required, much more room is occupied, and heavier foundations are necessary. The generating plant should be divided up into not more than 3 units, one being a stand-by. Where condensing water is not available, it will generally pay to adopt some artificial method of cooling the water, such as a cooling tower or spraying nozzles.

(To be concluded.)

LONDON COUNTY COUNCIL.

At last week's meeting Mr. Baker asked the chairman of the Highways Committee whether his attention had been drawn to the accident in connection with the overhead trolley system in Liverpool on the 6th inst., which resulted in the death of two persons and injuries to 14 others; and also to the accident which had occurred in Sunderland on the previous day. Mr. Parker (vice-chairman of the Committee) stated, in reply, that he had read of the accident in Liverpool, but so far as the Council was concerned, there would be no similar danger, because the Committee had adopted the conduit system, which dispensed with the use of overhead wires.

Provisional Orders.

The report of the Highways Committee reminded the Council that four applications for provisional orders this session are now before the Board of Trade, namely, those of the St. Marylebone Borough Council, the Marylebone Electric Supply Corporation, the Lewisham and District Electric Supply Company, for Lewisham and Penge, and the North Metropolitan Electrical Power Distribution Company, in regard to Stoke Newington. As regards Marylebone, it will be seen that the Borough Council is itself applying for an order for the same area as is proposed by the company, whilst the Lewisham and Penge and Stoke Newington orders, so far as they affect the County of London, relate to districts which are covered, or partly covered, by existing orders granted to the local authorities concerned in the Lewisham order, 1899, and the Hackney order, 1893. The Committee proposed to suggest that, following the usual course adopted by the Council in such cases, the Board of Trade should be requested not to grant any of the three orders applied for by the companies. The Borough Councils of Hackney and Stoke Newington had informed the Committee that they were opposed to the issue of the proposed Stoke Newington order, and had asked for the support of the County Council in the matter. In the event, however, of the Board of Trade deciding to grant any or all of the orders, there were certain questions which it was necessary to raise.

With reference to the price to be charged, the Committee were still of the opinion expressed in their report upon the electric lighting orders of the past session, that the maximum price should be 5d. per unit, which appeared from information that was available to be the average rate now charged to consumers. On the subject of the system of supply the Committee still thought it advisable that except with the express consent of the Board of Trade, the supply should be by continuous current, as that method had been found more satisfactory to consumers than the supply by means of alternating current. It was, however, pointed out that the Marylebone Company and the North Metropolitan Company proposed to supply on the continuous current system. Suggestions for amendments as to price and method of supply were made by the Council to the Board of Trade in regard to the orders applied for last year, but the Board did not see its way to adopt them. As, however, the Committee attached great importance to them, they thought that the Board should be asked to again give them consideration. Two of the orders—the St. Marylebone Borough Council and the Lewisham Company—incorporate the clauses of the Electric Lighting Clauses Act, 1899. That Act provides that the provisions contained in the schedule shall be incorporated with and form part of every provisional order made by the Board of Trade under the Electric Lighting Acts, but (*except* so far as any of the provisions are incorporated with any provisional order . . . . extending to the county of London) the Act shall not apply to the county of London. As the Clauses Act was not intended primarily to apply to the county of London the powers usually vested in the London County Council are necessarily omitted. The Committee therefore suggested that the Board of Trade should be asked to require the promoters of these two orders to set out clauses in the usual way, with such amendments as might appear necessary to give effect to the suggestions as to reduction of price and system of supply already mentioned.

The Highways Committee stated that they had prepared amendments* to give effect where necessary to the above suggestions for

* The terms of these amendments were not submitted to the Council.

submission to the Board of Trade with the amendments of a merely formal character. It was intended to intimate to the Board of Trade that the Council hoped that all orders that might be granted would be brought into the model form applicable to London, and that the date of purchase in the case of companies should be 42 years from August 26th, 1889. The committee then proceeded to deal with the applications individually.

Purchase by Local Authorities.—With regard to the powers of purchase of the three proposed company undertakings, the Highways Committee recalled the fact that the Camberwell order, 1896, contains a clause providing that at any time during the first 21 years after the granting of the order the local authority may purchase the undertaking upon payment of 1½ times the capital outlay of the undertakers, plus the sum necessary to make the dividends up to an average 5 per cent. from the commencement, and after the twenty-first year upon the same terms, but without the condition as to 5 per cent. dividend, or, as an alternative, on payment of the "then value," plus an allowance for goodwill. The Committee thought it advisable that this clause, which was agreed upon between the Vestry and the undertakers, should be inserted in the three orders if granted to the companies. It appeared that the County Council had no *locus standi* in the matter, and the Committee therefore suggested that the attention of the local authorities concerned should be drawn to it in order that they might make representations to the Board of Trade with a view to the insertion of the clause in the orders relating to their respective districts. The Committee expressed the opinion that it should also be suggested to the Borough Councils, as was done in the case of the orders applied for by companies last year, that they should ask that the option of purchase might be exercised at the end of every period of seven, instead of ten, years after the expiration of the first statutory period of 42 years from the date fixed by the order. On the recommendation of the Committee the Council resolved to make suggestions to the local authorities in the respects indicated.

The Marylebone Orders.—As to the order promoted by the Borough Council, the Highways Committee stated that it would be necessary to ask the Board of Trade to so amend the order that it might be brought into conformity with those previously granted to local authorities in regard to the county of London. Amendments had been drafted to secure this object, and also dealing with the points as to price, &c. The order also contained a clause in the usual form, enabling the powers granted under the order to be transferred. In view of the exceptional position occupied by one company to which an order granted to a vestry had been transferred, inasmuch as the company had, under the order, only to serve notices and plans of works, and the Council had no power, as in the case of orders granted to companies direct, of approval or disapproval of the works, the Board of Trade had in previous cases struck out the provision authorising the transfer of the undertaking. The Committee thought, therefore, that the Board of Trade should be asked to adopt the same course in relation to the Borough Council's order, and a recommendation to this effect and also embodying amendments prepared by the Committee, was agreed to.

With regard to the application made by the Marylebone Electric Supply Corporation, it appeared to the Committee that in pursuance of the policy hitherto adopted by the County Council in similar cases, the Board of Trade should be asked to give preference to the order applied for by the local authority. The Committee added that the whole of the area affected was already covered by an order granted to the Metropolitan Electric Supply Company in 1889. It was, therefore, decided to ask the Board not to entertain the company's application, but that should the Board for any special reason decide to allow the order to proceed, the amendments prepared by the Committee should be inserted in the order.

The Lewisham and Penge Order.—The Committee pointed out that a portion of the district included in this order—the parish of Penge—is situated outside the county of London. The remainder of the area is comprised within the borough of Lewisham, in respect of which the Borough Council already holds an order which was granted to its predecessor, the Lewisham District Board, in 1899. A very small part at Forest Hill of the area applied for by the order is not comprised within the Lewisham Order, but appears to be covered by the Camberwell (1896) Order of the County of London and Brush Provincial Electric Lighting Company. The Council, when an application has been made by a company for an order in respect of an area for which a local authority has already obtained powers, had hitherto adopted the practice of asking the Board of Trade not to entertain the application of the company, and that course should be taken in the present case. It appeared that a clause had been added in the order to repeal the Lewisham District Order, 1899. It was decided to ask the Board of Trade to exclude from the order the area covered to a large extent by the order granted to the local authority in 1899, but to ask for the insertion of amendments presented by the Highways Committee in the event of the Board resolving to grant the order as regards the whole or any part of the area within the county of London included in the order.

The Stoke Newington Order.—The Highways Committee explained that the greater part of the area included in this order is in respect of the borough of Stoke Newington, which is covered by the Hackney order held by the Borough Council, and in addition those portions of the borough of Stoke Newington which were at the time of the granting of the Hackney order in 1893, outside the County of London. The Borough Council of Stoke Newington, which exercises the powers granted under the order of 1893, so far as relates to the borough of Stoke Newington and the Hackney Borough Council, had each asked the assistance of the County Council in opposing the issue of the order, and the Committee considered that the Board of Trade should be asked to refuse it. A recommendation on this basis was adopted, and it was also decided to ask for the insertion of amendments in the event of the order being granted.

Electric Traction in South London.

The Highways Committee, in a further report dealing with conversion of the tramways between Tooting and Westminster, Kennington Park and Blackfriars, and St. George's Circus and Waterloo Station, stated that copies of the description and drawings of the Kennedy conduit system to be used on those lines had been forwarded to the Board of Trade for approval, and to the Borough Councils of Lambeth, Southwark and Wandsworth in order that they might have, in accordance with the Council's Tramway Acts, an opportunity of being heard by the Board on the matter. Some slight modifications of the system had been made at the suggestion of the Wandsworth Borough Council, which had now signified its approval to the Board of Trade, and the other Borough Councils had been informed of the alterations. It was, therefore, anticipated that the Board of Trade would, within a short period, be in a position to come to a decision with regard to the system. The report proceeded to state:—

> We have had before us estimates of the cost of reconstruction of the lines referred to, and of the buildings, machinery, and other plant which will be required for the electrical equipment and working of the tramways when reconstructed; and in order that matters may progress as quickly as possible after the system shall have been approved by the Board of Trade, the preparation of the necessary specifications, plans, and other matters, is, under our instructions, being proceeded with all possible expedition. We have already invited tenders for the supply of the boilers, &c., required for the generating station, as until the actual space which will be required for them shall have been ascertained, the designs for the buildings must be delayed. These tenders will be opened at the meeting of the Council on February 19th, when they will probably be referred to us for consideration; and we shall as soon as possible afterwards submit to the Council a recommendation for the acceptance of a tender. We think, therefore, that the time has come for us to ask the Council to authorise the capital expenditure necessary for the erection of the generating station which we propose shall be of sufficient capacity to supply electrical energy for the *whole* of the Council's tramways south of the Thames, and upon the works and machinery, rolling stock and electrical equipment of the lines above specified; and we are advised that the total amount which will probably be required for the purpose is £623,500, which may be roughly divided under two heads, namely (*a*) buildings and railway siding, £145,000, repayment of which might be spread over the full term of not exceeding 60 years, and (*b*) lines, machinery, generating plant, rolling stock, and electrical equipment, £478,000, repayment of which would be spread over 25 years.

The Committee recommended the Council to authorise the expenditure, but the consideration was adjourned until Tuesday this week, when the expenditure was duly approved.

THE MARCONI SYSTEM OF WIRELESS TELEGRAPHY.

Last week Dr. J. A. Fleming, F.R.S., addressed the Liverpool Chamber of Commerce on "The Marconi System of Wireless Telegraphy as Applied to Lightships and Lighthouses." The subject was of special interest to the mercantile community of Liverpool, most of the members of which are closely identified with shipping, and there was a large attendance. Mr. A. L. Jones, of Messrs. Elder, Dempster & Co., presided.

Dr. Fleming said that they would be aware that the subject had engaged the attention of Chambers of Commerce, and had been the subject of an inquiry by a Royal Commission, which had issued a very favourable report. A number of lighthouses were already in communication, but as regards lightships, the position of affairs was less satisfactory.

After describing the difficulties which attended the work of communicating with lightships by electric wires, owing to the movement and strain caused by tides and storms, Dr. Fleming said that the commissioners recommended that five lightships should be connected with the land, but the experiments had failed. In 2½ years no less than 27 failures of the couplings of those lightships had occurred, entailing, in some instances, days and weeks of delay.

Dr. Fleming reviewed the attempts prior to Marconi's, to establish telegraphic communication without the use of wires, touching briefly upon the work of Morse, Faraday, Lodge, and Preece. He then described the various tubes which had been invented by Hughes, Branly and Lodge for investigating the phenomena of ether waves, and proceeded to describe the Marconi coherer.

The system employed between Bournemouth and Alum Bay, Isle of Wight, a distance of 16 miles, was shown on the screen.

An improvement which Mr. Marconi had made was that, instead of connecting a sensitive tube with a long aerial wire, he introduced a type of tube technically known as a "jigger." This jigger enabled him to conduct his experiments over a greater distance and to get rid of disturbances due to atmospheric electricity.

Proceeding, the lecturer stated what had been done towards the practical employment of Mr. Marconi's system. In 1898 he had established communication between Bally Castle and Rathlin Island, 7½ miles distant. Communication had also been established between the South Foreland and the East Goodwin lightship. On the north coast of Germany the island of Borcom, 4 miles from land, had been brought into communication with a lightship 25 miles off, which is passed by the North German steamers. Ordinary commercial messages were transmitted from the steamers to the lightship, and then to land, at 10d. a message. The lecturer next spoke of Mr. Marconi's successful introduction of duplex telegraphy into his system and of the adoption of the system by the Admiralty between Portland and Portsmouth, a distance of 65 miles. During the last few weeks Mr. Marconi had done a remarkable thing. He had recently established a station at the Lizard, Cornwall, which was 200 miles from St. Catherine's, and on the first day of the reign of King Edward VII. Mr. Marconi succeeded in establishing perfect communication between St. Catherine's and

the Lizard, 200 miles distant. Since that time he had established perfect communication in both directions and arranged to duplex the line, so that he could send two messages each way at the same time, and there was no reason why he should not send 20 messages save the cost of the instruments.

The lecturer spoke highly of the suitability of the system for lighthouses and lightships. It could be used in any kind of weather, fog or fine, wet or dry—in fact, it worked better in wet weather than in fine—and it had been adopted by the Admiralty and Trinity House.

DIELECTRIC HYSTERESIS.

The paper submitted by Mr. Mordey to the Institution of Electrical Engineers on "Capacity in Alternate Current Working" revives the much-discussed question of the existence or non-existence of dielectric hysteresis. The paper was summarised under four heads by Mr. Swinburne in the discussion:—(*a*) The combination of capacity and inductance in parallel on an alternating circuit; (*b*) the measurement of capacity in terms of an alternating current; (*c*) the determination of dielectric loss; and (*d*) the construction of wattmeters. The determination of dielectric loss is the salient point to which most of the speakers in the discussion on January 10th and the 14th inst. devoted attention, and as Mr. Mordey has said in the paper, if it may be feared that the losses with underground cables are by no means the same as with aerial lines, the subject deserves the very serious attention of electrical engineers.

The question of the losses due to dielectric viscosity was first definitely raised by Ricardo Arno (Rend. della Accademia dei Lincei, October, 1892, and April, 1893), who applied Ferraris' method of testing the electro-magnetic qualities of iron to the investigation of insulating cylinders by placing a suspended cylinder in a rotatory electrostatic field, when it revolved. These experiments were continued by Hess, Steinmetz, Northrup, Blondlot, J. J. Thomson, Janet, Borel, Porter and Morris, Benischke, Eisler, and others. The general conclusion was that the existence of dielectric hysteresis analogous to magnetic hysteresis had not been demonstrated, and that the losses were due to dielectric viscosity or to internal conduction. On the other hand, Bedell, Ballantyne and Williamson deduced the curves of instantaneous pressure and charging current for a condenser, and considered that these proved the correctness of the hysteresis theory. This was accepted by Nichols, who, in his "Laboratory Manual of Physics and Applied Electricity," Vol. II., p. 192 (1894), gives "Experiment 55. Determination of Dielectric Hysteresis." Threlfall, in the *Physical Review*, May, 1897, demonstrated that prolonged drying practically eliminates the heating of a condenser dielectric with alternating currents. In the discussion this speaker remarked that Mr. Mordey said the loss he found was due to dielectric hysteresis, because copper and leakage losses had been ascertained and allowed for. But leakage losses were extremely subtle things. Sulphur gives results varying 10 to 1, depending upon time, direction, and magnitude of voltage. He considered there was an absolute theoretical bar to the establishment of Mr. Mordey's position on that point. Steinmetz measured the losses in a condenser in 1892, and found with a paraffined paper condenser, at a frequency of 170 periods, the load was nearly equal to 12 times that of a continuous current at the same pressure. It was usual to associate heating losses in the conductor with absorption. Kelvin has shown, however, the effects of spreading and discharges over surfaces. To avoid these, it was sometimes necessary to dry for days over phosphorous pentoxide, and when tested by the rotating field method, which avoided electric discontinuity, the losses might be reduced to $\frac{1}{10}$ per cent. It is the last trace of moisture that does the damage, and even then samples taken from the same mass, say, of resin, at the same time gave results varying as 3 to 4. The speaker considered that there is such a thing as a real dielectric loss, but you cannot get two scraps of dielectric having the same dielectric loss.

Prof. Ayrton, who spoke first in the discussion, and at considerable length, quoted his 1891 Physical Society paper as giving a very much smaller power factor than the figure of ·124 put forward by Mr. Mordey in the paper. He said that in the Swinburne condensers it was of the order of ·01, while Cardew found about ·063. Lombardi had obtained values of ·008 for paraffin wax, and ·042 for gutta-percha. He, therefore, considered a cable with ·124 most unnecessarily bad. The reply by Mr. Mordey at once was that he was startled at the result himself, but it had been confirmed by other experiments, and he had no doubt that the power factor in cables of the class tested was of that order.

Mr. Mordey, in his reply, practically asked for results by other experimenters to confirm or disprove his own. He had obtained certain figures, and believed them to be true. The contributions to the discussion which dealt with results were the speeches of Mr. C. P. Sparks, and of Mr. Minshall, the borough electrical engineer of Croydon. The former, after pointing out that with an inductive load on the mains the capacity of the cables may be a positive advantage, showed that as the capacity of paper cables—now generally replacing rubber, on account of lower price and greater durability—was only one-third that of rubber cables, the losses must fall, but even with extra high pressure the effects would not be really felt until the load rose so that the smallest unit in a works had to be replaced with larger plant, inasmuch as some reserve of power was necessary even on light load. He described fully some tests made by Mr. Mordey on the County of London mains to compensate for the capacity current, and supplemented the information given as to the tests taken to ascertain the actual loss by dielectric hysteresis or viscosity. The Shallenberger meter used was checked against a Kelvin alternating wattmeter; with true watts it read full watts, while with full current and full pressure, but with 90° phase difference between the circuits, it read nothing. He, and Mr. Minshall also, gave data from experiments made on the engineer's method of running a motor alternator first light without a cable connected, and then with the cable. We may deal with the actual figures next week. The final result was that with 50 miles of cable feeding a sub-station 12 miles away at a pressure of 6,000 volts, and with a 10 per cent. load factor, the loss would be, with rubber insulation, 8·3 per cent. By substituting paper this would be reduced, or 2·1 per cent. only of the units generated would be wasted in dielectric losses.

Dr. Sumpner referred to the ratio of capacity to load current on the cable, and stated that the proportion between load current loss to dielectric loss depended upon the percentage drop in volts allowable on the line. If the power lost in the line were important, then the loss in the choker (if such be used) was more important. Mr. Mervyn O'Gorman gave a physical explanation why the dielectric losses should be greater in rubber than in paper, attributing it to the potential gradient in the dielectric. Mr. W. E. Gray reminded the meeting that there were many things to bear in mind in connection with dielectrics, and that the results obtained depended upon the mode of manufacture, as a rubber cable could be made to give any capacity, within limits, but no one could make a cable absolutely stable without considerable dielectric resistance.

A good deal was said about the methods of measurement adopted, and as to the correctness of the formula used. Mr. Mordey admitted that his advice to station engineers was not wise under all circumstances, and warned them that enormous differences might be found, as the rule was not applicable within any limits at all unless the current be taken from a sine function machine. This was demonstrated by Mr. Mather's remarks on the figures he had obtained, which were as follows:—

Source of current.	Frequency.	Current at 100 volts.	Cap. calculated mfd.	True cap. mfd.
Ferranti machine ...	100	3·0	47·73	49·35
Pyke & Harris machine	100	4·6	73·23	—
Wenstrom converter {	43	1·18	43·68	—
	38	1·69	46·38	—
Gramme converter ...	23	0·7	44·38	—

Mr. Mather had tested different cables for power factor, and had found the following results:—

Cable.	Pressure volts.	Frequency.	Power factor.
British Insulated ...	2,017	100	·024
Callender	2,030	71·5	·027
Silvertown Rubber ...	2,000	103	·028
County of London Rubber	2,230	99	·033
"Mordey"	2,240	100	·124

Some criticism was levelled at the instruments by which such results as Mr. Mordey's were taken. Dr. Fleming said that no details of experiments to check the wattmeter had been furnished. He quoted Mr. D'Alton's method of taking engine indicator diagrams, by which it was found that on the Deptford cables years ago the power factor was proved to be nothing like 12 per cent., but ·2 or 2 per cent. He reminded the meeting that Mr. Swinburne once made a wattmeter that read low on his own open magnetic circuit transformers and right on others. The cause was shown by Dr. Sumpner to be eddy currents in the iron parts of the wattmeter. Instruments made with glue, shellac, and string did their duty free from this error, though lacking in finish. Again, a very slight difference in phase between the current in the pressure coil and that of the inducing E.M.F. means large errors; 7 per cent. difference might represent 2 H.P., and such "slim" instruments should be checked by practical methods. Dr. Sumpner also spoke on this point, and said that although a wattmeter might be right on lagging currents, it might be quite wrong on leading currents, and even read negatively. He thought Mr. Mordey must have had a slight lag in his volt coil, and this might produce very extraordinary results. Testing a 3-KW. transformer with full load a certain instrument gave the following results:—With condenser, + ·02, + ·06, + ·4; another way, — ·007, — ·13, and if adjusted on a non-inductive load — 1·6 as power factor. Many such instruments were useful to measure what you already know—not what you don't know. Mr. Swinburne talked of the method of measuring capacity employed and of his use of it with his condensers. He had found it a good check to use two-phase machines to test wattmeters, using two loads and two resistances; the connections could be changed and opposite phases obtained.

The discussion on the paper has had one good effect. It has caused the younger generation of engineers, who cannot be expected to be well acquainted with things which were done 10 or 11 years ago, to look up old Physical Society and Telegraph Engineers' *Proceedings*.* Mr. Mordey has done a kindly act in preparing his paper if it have no other result than in causing station men to work out carefully the theory of the wattmeter. It is wonderful how very difficult it really is to get a reliable measurement of power on a reactive circuit. The smallest lag in the volt coil of an instrument comes in to render the results fallacious, and even the Kelvin balance is by no means correct to the ¼ per cent. claimed by the makers on a highly inductive circuit, owing to the pressure coil being necessarily inductive.

HIGH SPEED TRAINS.

If electrical engineers would be more practical, they might lay down some line to the coast, and run the distance at 70 miles an hour. This would afford a practical lesson in electrical high speed traction, and would be better than so much high talk about 150 miles per hour, which never comes nearer. Mr. Rous Marten discusses the cost of high railway speed in the *Engineering Magazine*, and points out how the most ghastly failures in Britain have been the two slowest British railways.

Mr. Rous Marten objects to the oft-repeated cry that resistance increases as the square of the speed. Quite possibly air resistance increases at a considerable rate, but we cannot see good reason to suppose that rail or axle resistance can increase particularly with speed. There is no particular reason why rail resistance should so increase, but there are reasons why it should decrease to some extent. The case of the steam vessel is often brought forward as an example of the enormous increase of power required by increase of speed. But there is no parallel between the two cases.

In the first place, the resistance of a wheeled vehicle is made up of several resistances—the rail, the axles, the head and side-air resistances. In a ship there is practically but one resistance, the water is heavy and resists being pushed aside. It piles up ahead of the ship and puts the ship in the position of running against water that is always higher than the water level left behind, or it places the vessel in the position of running up hill. But for the necessity of moving the heavy water a ship would not be found to increase its resistance so excessively as it increased its speed. There is no parallel between the ship and the train, and we are much inclined to agree with Mr. Rous Marten that there are no good reasons why high speeds should not be regularly run. The North of France railway is the fastest in Europe, and pays 15 to 17½ per cent. The fast American trains pay, and the Scotch traffic has been greatly augmented since the accelerations of 1895.

We doubt whether on any English railway there are the truly right kind of directors. Mostly non-technical, their ruling passion is to place themselves in antagonism to the public, in place of regarding the public as the source of their prosperity and trying to please it. Our railroad directorates are too full of titled men, who occupy the posts because they are men of title, not in spite of their titles. Many years ago one could travel from London to Bristol at higher speeds than to-day, and there can be no doubt that the drivers, stokers, and guards of our English lines as a whole are paid twice as much per mile as would be paid if train service were respectably rapid. The waste of time imposed on the whole nation must be something terrific.

With high speed schedules unpunctuality would come to a stop. High speed pays, or would pay, if genuinely attempted.

INSTITUTION OF ELECTRICAL ENGINEERS (MANCHESTER SECTION).

ON THE TRAINING OF ELECTRICAL ENGINEERS.

By John T. Nicolson, D.Sc., M.Inst.C.E.

(*Paper read February 12th*, 1901.)

Electrical engineering differs from the other branches of the profession of the civil engineer in being based on theoretical principles whose application give predicted results which closely accord with those practically obtained. As Prof. Perry said in his Presidential address delivered a few months ago: "Most of the phenomena dealt with by the electrical engineer lend themselves to exact mathematical calculation, and after calculations are made, exact measurements may be made to test the accuracy of our theory. A completed machine, or any of its parts, can be submitted to the most searching electrical and magnetic tests, since these tests, unlike those applied by the mechanical engineer, do not destroy the body tested."

Although hardly true to allow the inference that all the tests made by the civil or mechanical engineer are necessarily of such a nature as to "destroy the body tested"; yet there can be no doubt that whilst electrical engineering is the youngest of the engineering sciences and arts, it has come clearly to the front in close physical accuracy of its theory; and in this department we have not been so notably troubled with a division into the two camps, of which we have heard so often, of those who believe in theory and those who believe in practice.

The reason for this difference from the civil, mechanical, or mining branches of engineering seems to lie in the circumstance stated by Prof. Perry, as follows:—"Electrical engineering owes its being altogether to scientific men, to the laboratory and deskwork of a long line of experimenters and philosophers. Even now the work going on in the laboratory, to-day, becomes the much larger work of the engineer to-morrow." It would thus appear that, in electrical engineering, practice has been largely directed by a consummate theory; whereas in other departments theory has, at its best, only endeavoured to understand and explain practice.

This fact has an important bearing on the subject we have before us to-night, for it is obvious that the relation between the theoretical and practical development of a branch of engineering must largely govern the principles to be followed in methodising the training of the students of that branch.

The other distinguishing feature of electrical engineering which

* The following are the papers most frequently alluded to in the discussion:—

Ayrton and Sumpner, Physical Society, March 6th, 1891.

Cardew, Institution of Electrical Engineers, May 21st, 1891.

Fleming, Institution of Electrical Engineers, May 7th, 1891.

The method of measuring capacity by observing the condenser current, &c., will be found in:—

Fleming, "The Alternate Current Transformer," Vol. II., Edition 1892, p. 408.

Nichols, "Laboratory Manual of Physics and Applied Electricity," Vol. II., Edition 1894, p. 172 ("Experiment 42." "Measurement of Capacity by Means of an Alternating Current.")

Bedell and Crehore, "Alternating Currents," Edition 1893, p. 79.

must be carefully borne in mind in the same connection, is the unparalleled growth of electrical industries in the past 10 or 15 years, and their present increasing rate of development. So much is this the case, that the task of keeping the professional training of the students of this branch of engineering abreast of current practice seems also a hopeless one.

This raises the all-important question whether it is within the province of engineering schools or colleges to impart technical instruction, properly so called, viz., to supply up-to-date information as to the practical details and processes of manufacture of machines, and to give instruction in such like mechanical arts, or whether it is their duty rather to confine themselves to the scientific principles that underlie engineering in general, and its several branches in particular.

I think the proper answer to this question has now been found in the general adoption of the laboratory as the proper adjunct and complement of every first-class school of applied science. Without the means of making experiments, the study of applied mechanics was closely analogous to, and, in fact, was an extension of the study of rational or theoretical mechanics. There were then certain data conceded as founded upon professional experience, and the course of instruction was confined to the consideration of the results flowing from reasonings based on these data; and to the working of problems and exercises in the application of these theories which were intended to form an introduction to the actual office work of the engineer in practice. It must be allowed that much of this excellent work is still and will always be necessary. Resting on a strong foundation of mathematics, physics and chemistry, the knowledge of the engineer must always include such pure sciences as those of kinematics, dynamics, hydro-dynamics, thermo-dynamics and electro-dynamics. A sound elementary acquaintance with all of these is necessary, and a specialised knowledge of that one more particularly useful to the engineer in his own branch must be obtained. It is, for instance, quite hopeless to try to explain to a man who has no knowledge of dynamics, upon what principles one proceeds in endeavouring to balance a locomotive. No amount of laboratory experiment will enable him to dispense with a knowledge of the mechanical principles involved.

Again, the fundamental principles of thermo-dynamics may not be of much use in helping a man to fix the size of the cylinders of a steam engine; but they will at all events keep him from wasting his time in trying to design a perpetual motion machine; and they will show him how far he can hope to go in the direction of the improvement of his heat motors, or other energy transformers.

But the province of the laboratory in the scheme of engineering education is: first, to extend scientific knowledge by providing more experimental data; and, second, to show to the student the scope, value, and limitations of the theories he has studied in the classroom.

Without laboratory work the young engineer is in danger of supposing that an engineering problem has been solved when a certain mathematical solution has been obtained from a basis of given physical assumption.

The *critical* or *engineering sense* is not developed in the classroom. The student cannot be expected to know which of the assumptions underlying his mathematical work is really close to practice; and which other, although the best that can be made, is far from being true. Since applied mechanics, or engineering, is not a complete science, but is constantly being revised as to its data and being added to as to its experimental laws, it is not sufficient to deal with it as with an abstract science having immutable laws and finally reasoned out consequences; on the contrary, the young engineer must be trained to exercise a salutary scepticism as to all generalisations from experience, and to, as far as possible, prove things in detail for himself.

Reverting to the question of instruction in up-to-date engineering practice, it may be added as the function of the laboratory—and more especially of the electrical engineering laboratory—that it should contain machines and instruments of the newest types procurable, which may serve as object lessons on the general trend of electrical engineering design. To avoid becoming an old curiosity shop it will be necessary in most schools to rely upon the assistance of manufacturers who are willing to lend their recent patterns of machines to the laboratory for testing and examination purposes for a reasonable time, in return for the supply of the experimental data and results obtained from the machine under test.

We have referred above to two features which distinguish electrical from other branches of engineering. They were:—First, the possibility of a closer approximation to practice in the theoretically predicted results of working; and, secondly, the extreme rapidity of development of this branch of engineering. It would therefore appear that, of the three uses of the laboratory in the school of engineering just mentioned, viz., the obtaining of new experimental data; the cultivation of the critical or engineering faculty in the student; and the exemplification of recent practice in design, the first and last are of greater importance than the second in electrical engineering laboratories. Inasmuch as the more closely a theory already seems to approximate to the actual phenomena obtained, the smaller is the need for overhauling this theory by checking its results by means of laboratory work. Yet one might argue that this close agreement only shows that the smaller and more intricate variations of the natural from the assumed laws, are nearer to discovery, and that a closer examination and study of the phenomena and more refined experimental work have become necessary.

In any case the personal verification of the data of his subject is very necessary for every student as a good working foundation to build upon, and as being the surest way of obtaining a real knowledge of and love for his adopted profession. According to Prof. Perry's address:—"There is one qualification which the electrical engineer must have, and without which all other qualifications are useless, and if a man has it no other qualification is supremely important, and this absolutely indispensable qualification is that a man should love to think about and work with electrical things."

I would wish to modify this rather sweeping remark by quoting another sentence from the same discourse, that, viz., "An electrical engineer must have such a good mental grasp of the general scientific principles underlying his work that he is able to improve existing things and ways of using these things."

This latter qualification, a knowledge of theory, he must acquire by private study and from his college lectures; the former will be best inculcated by experimental work in the laboratory.

I am, I suppose, to-night expected to state what I should consider the best or ideal training one would give to a youth entering the electrical engineering profession if the choice were open.

In reply, I say, in the first place, that in the case of a really clever student whose heart is in his work it is my experience that his course or mode of training matters very little. Even if he be trained on a very bad system, or not trained at all, he will acquire all the knowledge and experience he needs in spite of and in the teeth of the bad training. The desire to know and the love for his subject is enough for *him*.

But for the ordinary youth of mediocre abilities, whose inclinations have to be carefully coached in the right direction, and his all too easily flagging energies husbanded as much as possible, the sequence of his physical and mental treatment is of real importance.

In the first place, I hold strongly the opinion that, after leaving school, the boy who intends to become an electrical engineer should first spend at least two years in the workshops of a *mechanical engineer*. Here he will learn the elements of smithing, moulding, pattern making, fitting, machine work, and erecting. In this time he cannot help picking up the names and appearance of the common implements and processes fundamental to all kinds of engineering practice.

A boy of 16 having just left school has for a time had enough of bookwork, and will turn gladly and with great advantage to the complete change the workshop affords him. Here I may seem to be at variance with Prof. Perry when he says "Much of the evil we suffer from is due to our average young men being pitchforked into works, where they get no instruction, as soon as they leave school. If ordinary school education were worth the name, and if schoolmasters could be brought to see that we do not live in the fifteenth century, if boys were really taught to think for themselves through commonsense training in natural science, things would not be so bad. But the average boy leaves an English school with no power to think for himself, and with less than no knowledge of natural science, and he learns what is called mathematics in such a fashion that he hates the sight of a mathematical expression all his life after.

"And what is the result? English engineers do make a wonderfully intimate acquaintance with the machines and tools that they work with, but when it comes to the manufacture of new things they do it by fitting and trying, by quite unnecessary expenditure of money through trial and error. A machine is made and tried and then another better one, until a good result is arrived at. And this method did well enough in the past, and would do well enough in the future if only we had not to compete with foreigners who can really calculate."

I would point out, however, that the workshop course here proposed is merely the preliminary or first part of the student's professional training. If he has left school with the usual stereotyped stock of Euclid, algebra, and elementary physics and chemistry, I would have him take mathematics, physics, and chemistry classes in the evenings, but more especially mathematics, during these two years of workshop practice. Classes ought to be everywhere organised to teach mathematics for engineers in the manner proposed by Prof. Perry, so as to enable such a boy to learn as much useful mathematics as possible in the short time he has available.

I should advise the addition of another year of workshop practice in the shops of a dynamo manufacturer, if time permitted; but this will more usually have to be supplied by the laboratory of the college through which he must pass.

I have always found it extremely difficult to arouse, in the case of boys coming directly from school to the professional college, a lively and intelligent interest in their subjects of study.

Even with the help of a large and well-equipped college workshop, they cannot get the relation of their work to engineering practice properly established. They fail to realise the important bearing the theoretical work they are doing has upon their future careers, unless their curiosity has been first stimulated by a period of probation in the workshops, and a spirit of inquiry fostered by long-continued contact with actual engineering practice.

I have had some considerable experience in these matters, having served a four years' apprenticeship, worked in a number of drawing offices, studied in one and taught in two other Universities; and my experience, both as a learner and a teacher, leads me to recommend most strongly that, whenever possible, a period of workshop practice should intervene between school and college.

Having then put in two years in a mechanical engineering workshop, our ideal student ought to enter an engineering college at about the age of 18, and he ought to study there for not less than three years.

The first year of this college course will usually have to be spent on mathematics, physics, chemistry, dynamics; mechanical, geometrical and freehand drawing; and the study of French and German, which is so necessary for enabling him to read foreign technical literature.

In the second year the electrical engineering student must

specialise in the physical laboratory in the direction of electro-magnetic theory. He must study the magnetic qualities of iron and the hysteresis loss; and in doing so he must learn the construction of the instruments such as the galvanometers, voltmeters, and ammeters he uses in his work, and the methods of their calibration. All this experimental work should, of course, proceed hand in hand with instruction in theory and numerical exercises in the class room; where he should be working at electro-magnetism and the theory of the direct-current dynamo.

In this same year he must apply a considerable portion of his energy to the study of thermo-dynamics and hydraulics, and their application to steam and water-power plants, and he should devote great attention to the study of machine design and mechanical drawing. The electric engineer must have a special knowledge of applied electricity, but he must be, above all, an *engineer*, and not a mere electrician.

In his final year three-fifths of the student's time should be spent in the laboratories, one-fifth in the electrical engineering designing room, and the other fifth upon lecture courses connected with his laboratory work. About one-third of his laboratory time should be devoted to experiments on the strength of materials, on the simpler hydraulic phenomena, and to trials of steam engines and boilers. I think that at least 30 days of eight hours each should be spent in this way in his third year. Another third of the time spent in the laboratory in his last year would be occupied in completing the elementary electrical laboratory course he began in his second year. He would, after completing his work on magnetic testing, begin a study of the dynamo. For this purpose the laboratory would probably be provided with a number of direct-current dynamos of various types and styles of construction, of from 2 to 10 KW. capacity, which can be operated either as dynamos driven from a constant speed prime mover, or as electric motors.

Using the ordinary commercial instruments, such as voltmeters and speed counters, he should determine the strength of the fields of these machines when the armature windings are known and the speeds and pressures measured. He should compare the results obtained from the machines when running with those calculated from their dimensions. This will give the student an idea of the control which his classroom theories require from practical results, and to what extent uncertainty enters into his estimations. Tests of the magnetic circuit of dynamos, the regulation of dynames and motors with different forms of field winding, characteristic curves, and efficiency testing should naturally follow; and it is an excellent plan to make the student draw up tables and make curves of the variations in the principal proportions of machines of different types and sizes, in order that he may obtain an idea of the changes involved by particular conditions of service and output.

The data of this kind available in an engineering school are seldom of the latest, unless the teacher spends his summer in obtaining them. The instructor in electrical engineering has, as already mentioned, the special difficulty of the newness and constant development of his subject to contend with; but if he follows the practice of every year visiting the plants of the manufacturing companies and typical light and power stations, information is obtained which cannot be found in engineering literature, and which has the highest value for educational purposes. The cultivation of close relations between the college and the practising profession should indeed be part of the duty of instructors, and ought to be eagerly reciprocated by the members of the profession as one of the surest ways of meeting foreign competition. The professional status of the teacher of engineering in this country is not by any means so high as we find it to be abroad. In the *Electrician* of February 1st I read:—"It is announced in *Elektrotechnische Mittheilungen* that Herr von Dolivo-Dobrowolski, chief electrician of the Allgemeine Electricitäts Gesellschaft, is shortly going to Petersburg to take over the direction of the new Government Electro-Technical Institute there. The same journal states that Herr Görges is giving up his position as engineer-in-chief of the firm of Siemens & Halske to fill a professorship at the Dresden Polytechnic." I have yet to learn of any appointment in a college or technical school in Britain whose attractions could induce its acceptance by the engineer-in-chief of any of our great companies! The fact is, the Germans and Russians have come to realise the value of the scientific and technical training they provide in their polyteknikums the national industry and well being; whilst in Britain we are still content to muddle along in our honest but stupid old way. To return to our third-year student. The remainder of the second third of his laboratory time will be filled up by work in electro-chemistry and alternate current work. The former subject seems now to demand a laboratory equipment almost on a par with that of the dynamo room itself in a first-class school. The latter is usually better represented, and the enormous importance of polyphase currents in power transmission renders it necessary that every effort should be put forth to give sound instruction in this field. The effects of inductance and capacity are at the root of a large proportion of alternate current phenomena, and the fundamental studies in this department accordingly have reference to the study and measurement of these properties. The object of the teacher must be to convey to the electrical student as lively and practical a working conception of inductance and reactance as that usually given him of Ohm's law and its results. The student should have at his disposal a number of coreless solenoids for the direct measurement by ammeters and voltmeters of their self-inductances, using an alternating current of known frequency, and the comparison with their mathematically determined coefficients. He should also be able to make, by the use of ammeters and ballistic galvanometers, the direct measurement of mutual inductances, and to compare self and mutual inductance with capacity. He should then extend his measurements to circuits with iron cores. Carefully wound long and short solenoids having known constants, condensers of known capacity, bridges, alternating current ammeters and voltmeters, the ballistic galvanometer and secohmeter, are the instruments he will employ most at this stage.

The student should then pass on to the study of the alternator and to single-phase currents. The wattmeter and the alternate current curve-tracer must be put in his hands; and the relations of the current and pressure waves in circuits must be studied from the curves, as well as from measurements of the true and apparent energy in the circuits. This study is finally applied to transformers of various types of construction. For the study of polyphase currents it would seem best to have in the laboratory a rotary converter, so that currents of variable frequency may be obtained. Induction motors of representative types of construction ought also to be available.

A large part of the work here specified on alternate current machinery must, however, be relegated to the next division of the laboratory work of his final year, when he will have more time for uninterrupted experimental work, and be left more to his own initiative. The great matter is to instil habits of personal investigation and critical study into the mind of the young engineer, so that his college course may form really a graduated introduction to the work of his whole life.

This last portion of his laboratory time should be devoted by our embryo electrical engineer to what is, in America, called "thesis" work. This is of the nature of an experimental research, carried out either by the student himself or by a small group of students of which he is one. Very much valuable information has been obtained in American colleges in this way regarding the various types of new apparatus continually coming out; and it is found that the students learn in the course of such work to assume responsibility by being in a large measure left to their resources. Such investigation usually requires either special apparatus or the loan of new types of machinery; but good work may also be got by making progressive tests of an operating plant either in the college or elsewhere. The interest, and even enthusiasm, with which this part of the work is taken up and carried on by the students is very striking and encouraging, and was such as to lead the writer to adopt the "thesis" system in his late laboratories at McGill College, Montreal, although quite contrary to his preconceived prejudices against the utility of allowing undergraduates to undertake research work.

(To be concluded.)

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS, 1901.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, to whom all inquiries should be addressed.

2,317. "An improvement in electric stop motions for warping machines." T. Holt, Limited, and F. A. Holt. Dated February 4th.

2,320. "Improvements in the method of covering cables, wires and conductors for electrical purposes with india-rubber or other insulating material and in machinery therefor." W. Haughett. Dated February 4th.

2,321. "A double wheel contact on a rocker for overhead electric tram contact." H. Garstang. Dated February 4th.

2,330. "Improvements in and connected with controlling arrangement in telephone exchanges for branch or trunk lines." H. Oppenheimer. (Actien Gesellschaft Mix & Genest, Germany.) Dated February 4th.

2,345. "Electric meters." E. S. Halsey. (Date applied for under Patents, &c., Act, 1883, Sec. 103, July 5th, 1900, being date of application in United States.) Dated February 4th. (Complete).

2,358. "Improvements in gear for collecting the current on electric locomotives, electric trams, electric cranes and such like machines." E. C. Wilson. Dated February 4th.

2,363. "Electrode for galvanic cells." F. Landolt. Dated February 4th.

2,394. "Improvements in distributing electricity and in apparatus for use therein." R. B. Ransford. (La Société Anonyme des Brevets Dolter, France.) Dated February 4th. (Complete.)

2,411. "Improvements in and relating to electric meters." M. Kallmann. Dated February 4th.

2,421. "Improvements in electric incandescent lamps." J. J. Green and E. O. Green. Dated February 5th.

2,428. "Improvements in electric motor starting switches." E. W. Cowan and A. Still. Dated February 5th.

2,461. "Improvements in conduits for electric wires." E. D. Page. Dated February 5th.

2,471. "Improvements relating to electric switches." H. H. Lake. (W. M. Scott, United States.) Dated February 5th.

2,474. "Improvements relating to transmitters for telephones." L. Mellett and A. F. Henderson. Dated February 5th. (Complete.)

2,488. "Apparatus for disinfecting the transmitters and receivers of telephones." C. F. Axtell. Dated February 5th. (Complete.)

2,490. "Improvements in storage batteries." T. A. Edison. Dated February 5th.

2,497. "Improvements relating to electric igniters." J. M. Ricard and F. C. Cory. Dated February 5th.

2,505. "Improvements in, and in apparatus for, obtaining metals by electrolysis." A. P. Strohmenger and A. B. Pescatore. Dated February 5th.

2,523. "Improvements in means for the distribution of electricity on the three-wire system for electric traction on rails." A. B. Blackburn and E. S. W. Moore. Dated February 5th.

2,536. "Improvements relating to the commutators of dynamo-electric machines." W. Langdon-Davies. Dated February 6th.

2,553. "Improvements in electric arc lamps." A. Eckstein and A. E Angold. Dated February 6th.

2,570. "Improvements in or connected with electrical signalling apparatus." W. J. MILDON. Dated February 6th. (Complete.)

2,579. "Fabrics for electric heating purposes." J. M. C. HERRGOTT. Dated February 6th.

2,587. "Improvements in electric batteries." G. ROSSET. Dated February 6th.

2,607. "Improvements in electrical transformers." A. F. BERRY and THE BRITISH ELECTRIC TRANSFORMER MANUFACTURING COMPANY, LIMITED. Dated February 6th.

2,618. "Improvements in electrical heating apparatus." A. LOACKER and F. RIELD. Dated February 7th.

2,619. "Improvements in electrically-heated smoothing irons." A. LOACKER and F. RIELD. Dated February 7th.

2,636. "Improvements relating to overhead electrical conductors such as trolley wires for electric trams and the like." A. PASS. Dated February 7th.

2,659. "Improvements in electric arc lamps." HELOIS UPTON COMPANY and T. SPENCER. Dated February 7th. (Complete.)

2,689. "Improvements in or relating to electrolytic electricity meters." F. M. STAUNTON. Dated February 7th.

2,692. "Improvements in incandescent electric lamps." L. LOBENTHAL. Dated February 7th. (Complete.)

2,696. "Improvements in means for protecting electrical conductors." W. LANGDON-DAVIES. Dated February 7th.

2,729. "Improvements in apparatus for regulating electric generators." COUNT A. DE DION and G. BOUTON. Dated February 8th.

2,741. "Electrode-plate for forming Planté cells." R. HAGER. Dated February 8th.

2,776. "Improvements in electric fuses." CALLENDER'S CABLE AND CONSTRUCTION COMPANY, LIMITED, and J. O. CALLENDER. Dated February 8th.

2,779. "Improvements relating to electric conductors." W. G. POTTER. Dated February 8th.

3,793. "Improvements in, and in connection with the storage of electricity." S. COWPER-COLES. Dated February 9th.

2,806. "Improvements relating to electric light fittings such as electroliers, brackets, and the like." R. B. LEACH. Dated February 9th.

2,830. "Improvements in means for electrically igniting miner's safety lamps." R. O. BEST and ACKROYD & BEST, LIMITED. Dated February 9th.

2,834. "Improvements in or relating to telegraph apparatus." F. G. CREED and W. A. COULSON. Dated February 9th.

2,835. "Improvements in the manufacture of thermo-electric couples." E. HERMITE and C. F. COOPER. (Date applied for under Patents, &c., Act, 1883, Sec 103, August 1st, 1900, being date of application in France.) Dated February 9th. (Complete.)

2,836. "Improvements in the manufacture of thermo-electric couples." E. HERMITE and C. F. COOPER. Dated February 9th.

2,838. "Apparatus for governing the output of dynamos when driven at different speeds." H. J. J. HUMMEL. Dated February 9th.

2,853. "Improvements in electric batteries." G. W. JOHNSON. (Société Paul Chapuy & Co., France.) Dated February 9th.

2,854. "Improvements relating to apparatus for starting and regulating or controlling electromotors." J. WETTER. (The Elektricitäts Aktien Gesellschaft vormals Schuckert & Co., Germany.) Dated February 9th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. THOMPSON and Co., 322, High Holborn, W.C., and at Liverpool, Manchester and Birmingham, price, post free, 9d. (in stamps).

1899.

6,160. "Improvements in or relating to facsimile telegraph apparatus." A. J. Boult (Dr. W. P. Dunlany). Dated March 21st, 1899. Relates to that class of facsimile telegraphs in which a rotating cylinder is traversed by a receiving or transmitting stylus which is mounted on a carriage moved by a traversing-screw. An electric motor is provided with a governor controlling a switch for cutting the resistances in and out of circuit. The motor is connected by gearing with the screw and cylinder shafts; each shaft is arranged with two speeds, the one shaft having a sliding key clutch, and the other shaft a screw sleeve for locking either of the loose wheels on to the shaft. The shaft is provided with insulating thimbles and supports the record, which may be of varying diameter to suit different desired results. The shaft is provided at one end with three rings—(1) of metal and having a small insulating section rubbed by a brush in one synchronising circuit; (2) of insulating material and having a small conducting sector corresponding in position to the insulating sector on and connected to (1), this ring being in the second synchronising circuit and rubbed by the brush; and (3) of metal and connected to the record cylinder (this ring being rubbed by the brush in the line circuit). The synchronising magnet has a tripping armature controlling the movement of the lever that can engage with the unison stop on the ring. The cylinder may be split longitudinally, and is then provided with internal gripping rollers for fixing the transmitting or receiving sheets in position; a filling-piece is provided to make good the surface of the cylinder between the rollers. The travelling carriage is mounted on the rod and roller. The transmitting and receiving styli and the receiving magnet are mounted on a sliding support to allow of different sizes of cylinders. The receiving stylus consists of a small finely-toothed wheel when it is desired to make a record by means of transfer paper. The apparatus may be worked with relay circuits when it is desired to produce reversed results. 13 claims.

6,205. "Improvements in or relating to electric motors and vehicles." M. Soir. Dated March 22nd, 1899. Relates to controlling and safety devices for electric vehicles. When the treadle is actuated to apply the brakes by means of the levers, the link causes the pivoted lever to push the pivoted end of the stop aside and break contact, which cannot be remade until the main switch handle is turned to place resistances in the circuit and the cam on its spindle causes the rod to turn the bell crank and draw back the stop, allowing the spring to return the lever to its normal position. The gear-wheel, which is attached to the hub, and driven from the motor shaft by the pinion, is surrounded by a dust-proof case and braked by the band, guided by the spring pin, and connected by links to a lever fixed to a rotatable stud having a handle to which the operating chain is attached. When two brakes are fitted, a single chain is used to apply them equally and simultaneously. 12 claims.

6,220. "Improvements in electrical incandescence lamps." Siemens Bros. (Siemens und Halse Aktien-Gesellschaft). Dated March 22nd, 1899. Relates to incandescent arc lamps. A body formed of a refractory oxide or the like placed between two electrodes is heated to incandescence and rendered conductive by moving an arc or spark discharge along it, beginning at one electrode, so that the body is gradually heated, which can be effected by a current at a comparatively low pressure. The invention differs in this respect from that described in Specification No. 1,996, A.D. 1877. The body is afterwards kept incandescent by the current it conducts. One form of lamp is illustrated. The refractory body is held between a support and a spring-pressed electrode, the end of the support being protected by a renewable copper cap. The parts are connected through an electro-magnet with the terminals of the lamp, which may be supplied with current through a choking coil or other steadying means. The armature of the electro-magnet is pivoted to the socket of the electrode, and carries a carbon rod, which touches the cap until current is supplied to the lamp, when it moves parallel to the body; an arc is struck between the parts, and rises between the rod and body as this becomes conductive, until it reaches the top and goes out. The arc may be started by other means, and its upward movement may be assisted by a movable magnet, or otherwise, or may not be automatic. 3 claims.

6,322. "Improvements in or relating to electric cables." A. Whalley. Dated March 23rd, 1899. Armoured cables have the lead sheathing protected by double spirals of unvulcanised rubber or equivalent non-fibrous material, the joints of the spiral being made good by heating or by the heat in the wax-impregnated jute covering. When the cables are to be laid in the earth spiral armourings of steel and an external jute coating may be added. 4 claims.

6,335. "An improved device for producing electric current at sea by the action of the waves." M. Gehre. Dated March 23rd, 1899. Relates to means for generating electric currents at sea by the action of the waves, more particularly for use in the production of flash lights. In one arrangement a number of magnets of alternating polarity are carried by an anchored rod, and an armature or induction coil is reciprocated in front of the magnet poles by means of a rod in connection with a pivotted lever, which carries at each end a float under the influence of the waves. Alternatively the armature may be stationary and the magnet or magnets reciprocated. In a modified arrangement the actuating float is pivotted to a pair of floating bodies anchored to the bottom of the sea, while in a further modification a floating body is arranged to move up and down on a pair of rods fixed in the bottom of the sea. 1 claim.

6,349. "Improvements in telegraph and such like posts." Siemens Bros. and Co., Ltd., and G. W. Perry. Dated March 23rd, 1899. Telegraph and like posts are steadied in soft ground by means of a steadying plate through an aperture in which the post is driven, forcing it into the ground. The plate has inclined ribs, and the post may have a shoulder or collar. 2 claims.

6,473. "Improvements in electrical apparatus for igniting gas burners from a distance." C. Bolle. (C. Fitzlaff.) Dated March 25th, 1899. When the gas cocks are actuated and the burners ignited from a distance by electrical apparatus, the parts are so arranged that a stronger current is required to effect the opening than the closing of the gas cock, which is thus closed with certainty when the same current is employed throughout. The ignition and extinction bobbins are of equal power, but the core of the ignition bobbin is farther from its armature than the core of the extinction bobbin is from its armature and the ignition armature has, in addition, to lift the spring-loaded sparking rod which is located within the pilot jet. The opening and closing of the gas cock is effected by the transmission by means of the arms of the movements of the armatures to an arm on the cock. 2 claims.

6,593. "Improved combination brake coupling for electrically connecting railway vehicles fitted with vacuum brakes for communication or signalling purposes." D. Cunningham. Dated March 27th, 1899. Relates to a coupling joint for pneumatic or vacuum brakes for railway and like vehicles provided with electrical contacts for electrical communication or signalling purposes. The brake pipes are coupled by the usual lugs, slots and hooks. Two ears or lugs are formed on the metallic collars, and each lug receives a hollow insulator. The electric cables are connected to the metallic pins, which are provided with suitable heads and are kept in contact by the springs. 2 claims.

6,685. "Improvements in voltaic cells." R. O. A. Heinrich. Dated March 28th, 1899. Relates to H-shaped cells in each of which is a liquid electrode and a common electrolyte. The invention consists in constructing the diaphragms which separate the electrodes from the electrolyte of two perforated discs, either made in one with, or fixed on, a vent tube. The lower disc is preferably funnel-shaped. The space between the discs is packed with a porous material such as asbestos. The tubes serve as vents for the air in the bottom of the tubes when filling the cell up. After the electrolyte has been filled into the cells, they are closed by a layer of paraffin, a piece of cork, and a hot sealing mixture. 5 claims.

6,687. "Improvements in porous diaphrams for electrolytic cells and methods of producing the same." H. H. Dow. Dated March 28th, 1899. Relates to producing diaphragms electrolytically in the position where they are to be used. A solution of sodium, calcium, and magnesium chlorides is electrolysed, metallic iron being added near the anode. The hydrates of sodium, calcium, and magnesium are formed near the cathode, and commence to diffuse towards the anode, while chlorine is formed at the anode, and combines with the iron to form iron chloride. The hydrates melt the iron chloride, and are decomposed, iron hydrate precipitating and beginning to build up the diaphragm, while during the whole process any sodium, calcium, or magnesium hydrate passing towards the anode is similarly decomposed, so that, finally, on the anode side only iron hydrate is found. On the cathode side, however, where there is no iron chloride, in addition to the hydrates of calcium and magnesium formed as above, a further quantity is obtained by the action of the caustic soda upon the calcium and magnesium chlorides, so that the cathode side of the diaphragm is finally built up of these hydrates. A porous coherent diaphragm of two layers is thus formed, each layer of which is capable of retarding or preventing diffusion of the product of the electrode adjacent to it and of chemically destroying the product of the electrode of the opposite compartment while electrolysing the solution. A soluble iron salt may be used instead of metallic iron in the neighbourhood of the anode. One or more sheets of porous material, such as paper cloth, asbestos and the like, may be used as a nucleus to form the diaphragm, but this has not been found necessary or advantageous. 16 claims.

6,690. "Improvement in method of, and means for, varying the speed of direct current motors." B. G. Lamme. Dated March 28th, 1899. (Date under International Convention, September 3rd, 1898.) Controlling motors. The speed of a direct current motor is varied by varying the armature reaction, and consequently the field magnet strength of the motor, by connecting one or more auxiliary alternating current circuits to the armature winding, and adjusting the phrase relations between the current and electromotive force of the said circuit or circuits. 3 claims.

6,691. "Improvements in systems of electrical distribution and regulation." B. G. Lamme. Dated March 28th, 1899. (Date under International Convention, September 28th, 1898.) Relates to arrangements for regulating the speed of rotary transformers in systems in which direct currents are converted into alternating. In one arrangement a generator supplies continuous current to the rotary transformer, which supplies two-phased current in the conductors. The speed is maintained approximately constant, though the load on the alternating current side varies, by the use of choking coils arranged across the conductors. Adjustment is obtained by varying the length of the coils or cores, which then act automatically within limits. 2 claims.

6,712. "Lines, circuits and apparatus for telephonic inter-communication." G. A. Poelard et Cie. Dated March 28th, 1899. (Date claimed under International Convention, August 30th, 1898.) Relates to arrangements for working telephone exchanges, in which two exchanges are connected by means of a number of pairs of lines to facilitate the connection of pairs of subscribers on the two systems. Modifications are described to enable two different telephone working arrangements to be connected together, and for providing the two exchanges with through metallic or transformer plug circuits. The exchange circuits and apparatus are arranged automatically to cut out the operator's instruments as soon as the call is answered, and in all modifications to control the ordinary visual, and the supervisory signal lamps so that the operators at the two exchanges can tell the state of all the lines and connections. The apparatus is too complicated for purposes of abridgment. 14 claims.

6,894. "Improvements in or relating to electrical measuring instruments." J. S. Townsend, H. A. Wilson, J. A. McClelland. Dated March 30th, 1899. A multicellular voltmeter has its cells or movable vanes separated by insulation into two or more groups which are connected with the springs of a rotatable disc switch, by which either all the parts may be connected to co-operate, or some of them may be cross-connected to have no action on the movable axle of the vanes. Preferably the cells are so separated, all the vanes being connected together. Vanes and cells of different sizes may be used in one instrument. The cells are formed of semi-circular plates, carried on bolts of insulating material, and separated by short metal and ebonite sleeves thereon. The vane is connected electrically with the plate and deflecting over the plate approximately proportionately to their difference of potential. Vanes in different cells are set symmetrically upon the axle. 6 claims.

6,947. "An improved vertically, horizontal, and angularly adjustable stand or support." J. Schulz. Dated March 30th, 1899. For transforming a continuous current into a second continuous current of a different voltage, the current first converted into an alternating current, and this current transformed by stationary transformer. The secondary current is then rectified. 2 claims.